2019

Lifestyle and Obesity in Canada-A Quantile Regression Approach

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A Major Research Paper
Submitted to the Faculty of Graduate Studies
through the Department of Economics
in Partial Fulfillment of the Requirements for
the Degree of Master of Arts at the
University of Windsor

Windsor, Ontario, Canada

2019

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May 3, 2019

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Abstract

Objective: This study examines the relationship between BMI and some life-style variables, socio-economic status (SES) variables, and some socio-demographic variables related to behavior of individuals along different points of the BMI distribution by using quantile regression. **Methods**: A representative sample of 34,225 individuals of Canada form the Canadian Community Health survey 2014 is selected to conduct this study. Ordinary least squares (OLS) method is used at first to differentiate the results between conditional mean framework and conditional quantile framework. Quantile regression is estimated to analyze the heterogeneous relationship among fruits and vegetables, physical activity and BMI. **Results**: Analyses expose that fruits and vegetables intake and physical activities are negatively associated with BMI and statistically significant both for male and female. The estimates are larger in the higher quantiles for individuals. OLS overstates these associations at the lower quantile and understates at the higher quantile of the distribution. **Conclusion**: Findings of OLS that assumes equal responses may be misleading. The study finding suggest that effective dietary strategy and appropriate physical consciousness strategy may be helpful to reduce the risk of obesity and overweight.

Keywords

Life style, fruits and vegetables, physical activity, BMI, quantile regression

Acknowledgement

I would like to express my special thanks of gratitude to my supervisor Professor Dingding Li for her guidance, understanding, encouragement, and patience. Professor Li has given me so many useful advices, which makes me feel motivated and enthusiastic to do better. I have learned a lot from her. I am also grateful to Professor Yuntong Wang for his invaluable instructions and comments on my paper. He has provided me a lot of help in writing. I have got a strong base of support from them. Last but not least, I would like to thank all my Professors for teaching and supporting me in a way that I have reached this far and all my classmates for making days we spend together memorable.

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INTRODUCTION

Life-style is directly related to a person's health status. The rise in obesity has adverse effects in the prevalent health condition of Canada and it has become a challenge for the policy makers to overcome this prevalent crisis. According to reports from the World Health Organization (WHO[3]) and the Food and Agriculture Organization (FAO) (2003), daily consumption of five servings, or a minimum of 400 grams with one portion of 80 grams, of fruits and vegetables (fv) helps in preventing several diseases. The Health and Social Care Information Centre of United Kingdom, 2013, converted portion sizes for different food items to everyday units to make it easier for people to calculate (and monitor) their daily consumption which is shown in table 1. An 80 grams portion is equal to three tablespoons of vegetables, a cereal bowlful of salad or a medium fruit (such as an apple). According to Statistics Canada[3], fruits and vegetables (fv) are negatively associated with obesity. Obese people have high risk of having several health issues like asthma, arthritis, back problems, high blood pressure, diabetes, thyroid disorders, activity limitations, heart disease, urinary incontinence, and repetitive strain injuries (Statistics Canada[4]).

The rising obesity rate in Canada has been accompanied by increasingly poor eating pattern among Canadians (Azagba and Sharaf, 2011). Consumption of fv has numerous benefits including lowering the body weight, as those are full of water and fiber. Despite the benefits people do not eat sufficient amount of fv. According to Canadian Community Health Survey (CCHS) 2014, 60.5% of Canadian people reported consuming less than five times a day and this fraction is increasing day by day.

Several studies have argued that technological innovation is one of the main reasons in increasing body weight. Lakdawalla and Philipson (2002) in their study find that the growth in weight results from the agricultural innovation and also from technological changes in home and market production as it declines physical activities. They argue that technological improvement rises the economic growth and thus helps to gain overweight. Bleich et. al. (2008) have also found the same result, calorie intake rises with the technological innovation and helps to become obese. There is indirect effect of fv on BMI through its prices, and prices of fv are positively associated with adolescents BMI (Auld and Powell, 2009). Men consume fewer servings of fruit and vegetables than women as men are less likely to concern about the healthy recommendations (Baker and Wardle, 2003).

Obesity is not just a health related problem, it creates several social and economic problems. The economic cost related to obesity is substantial (Katzmarzyk and Janssen, 2004; Finkelstein et. al., 2005), and if the benefits exceed the costs, it should be avoided through behavioral changes. Socio-economic status (SES) can be a significant factor to determine an individual's body weight. Education is an SES factor which has a significant impact on determining the obesity or overweight of a person. McLaren (2007) examined more than three hundred published studies to determine the association between obesity and SES. His findings suggest that there is a negative and significant association between SES and body weight among women in highly developed countries, whereas the relationship is positive and non-significant among men.

Obesity rate is rising worldwide. According to WHO[1], it has tripled from 1975 to 2016, and in 2016, more than 1.9 billion adults (39%) - 18 years and older - were overweight. Of these over 650 million (13%) were obese. Canada is one of the countries with higher rate of obesity. Obesity can be prevented not only by consuming more fv, but also by physical activities (Vitale and Doherty, 2016). WHO[2] suggests some ways to reduce obesity or overweight, increasing consumption of fruit and vegetables, and engaging in regular physical activity are the most important among those. Left pie of figure 1 shows the fraction of the underweight, normal weight, overweight and obese Canadian people and the right pie resembles the share of the active, moderately active and inactive Canadian adults, whereas the bottom pie shows the percentages of Canadian people taking fv less than 5 per day, 5 to 10 per day and more than 10 per day.

The objective of this study is to examine the relationship between BMI and some life-style variables, socio-economic status (SES) variables, and some socio-demographic variables related to behavior of individuals along different points of the BMI distribution. The study contributes in the following manner: First, the limitations of applying standard estimation models are reduced by applying quantile regression to get the nonlinear association across the different quantiles of the BMI distribution. Second, instead of examine the bivariate association between fv and BMI or physical activities and BMI, followed by most of the previous studies, this study includes a wide range of potential determinants of BMI. Third, most of the previous studies with multiple variables mostly use linear regression methods to examine the conditional mean of BMI, whereas this paper uses both conditional mean for linear association and conditional quantile for nonlinear association. Policy makers may want to give more attention to the individuals who are obese or overweight, that is in the upper quantiles of the BMI distribution. Ordinary Least Squares (OLS), estimates the average effect which may over or under estimate the influence of the covariates at different points across the BMI distribution.

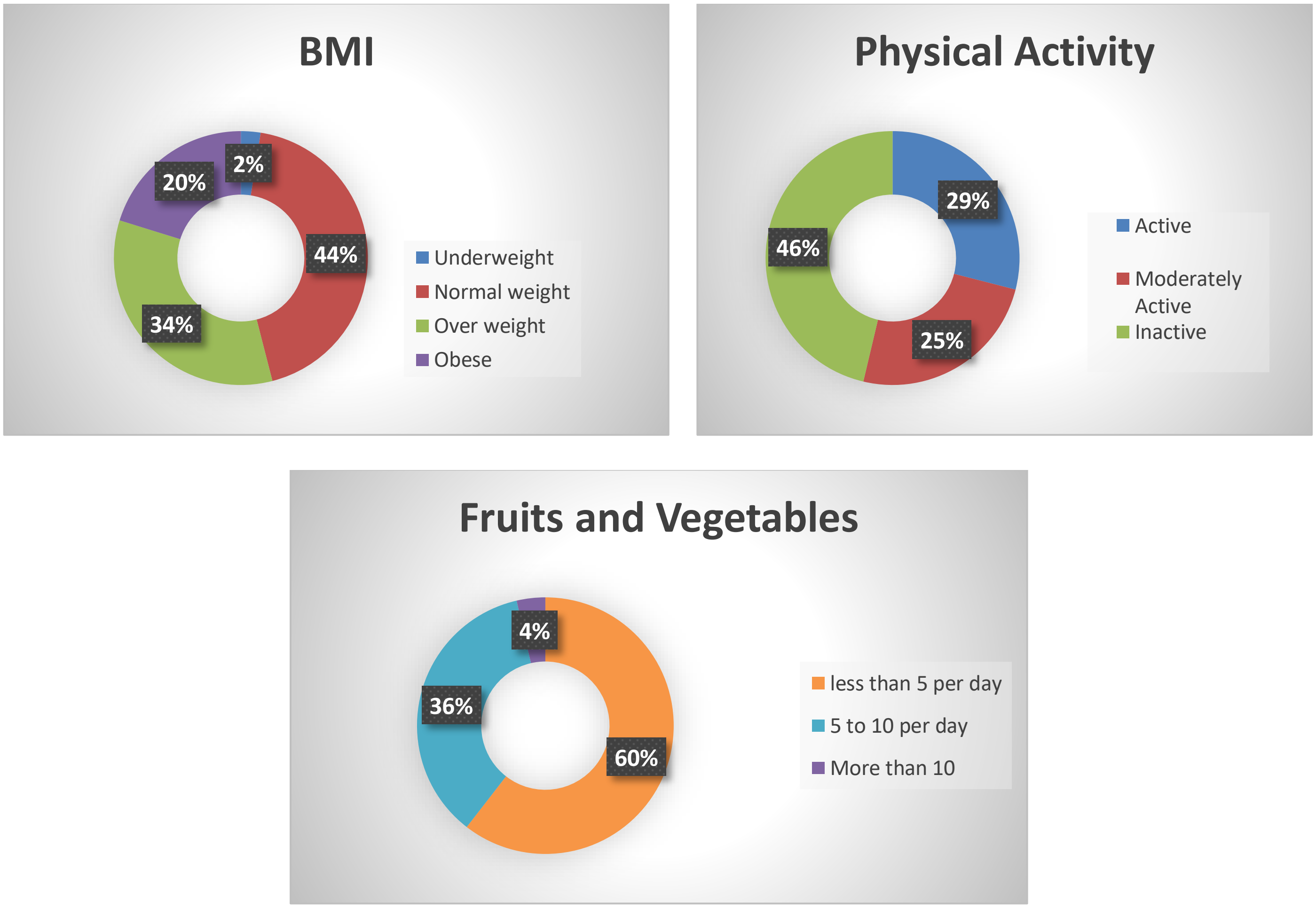
Remaining of the paper is divided into 6 sections: section two consists data part used in this study, section three provides background information related to the estimation techniques and tests. Methods are discussed in section four, and section five analyzes the results of this study. The last parts of this paper discusses the results and rationality of getting this results, and the very last part includes concluding remarks.

Table 1: Measures of Portion size of different food items

Portion size of different food items	
Food Item	**Portion size**
Vegetables (fresh, raw, tinned and frozen)	3 tablespoons
Pulses	3 tablespoons
Salad	1 cereal bowl
Vegetables in composites, e.g. vegetable curry	3 tablespoons
Very large fruit, e.g. melon	1 average slice
Large fruit, e.g. grapefruit	Half a fruit
Medium fruit, e.g. apples	1 fruit
Small fruits, e.g. plums	2 fruits
Very small fruit and berries	1 average handful
Dried fruit	1 tablespoon
Frozen fruit/tinned fruit	3 tablespoons
Fruit in composites, e.g. stewed fruit	3 tablespoons
Fruit juice	1 small glass (150 ml)

Source: The Health and Social Care Information Centre, 2013

Figure 1: BMI, Physical Activity, and Fruits and Vegetables



Source: CCHS 2014, Statistics Canada

DATA

Canadian Community Health Survey (CCHS) 2014 data from Statistics Canada[1] is used in this study. CCHS is a cross-sectional survey for Canadian residents that collects information related to health behavior. It provides national, provincial and intra-provincial levels of health data and the sample size each year is approximately 65,000. The CCHS produces an annual microdata file and a file combining two years of data. To conduct this study, I have used microdata of 2014 which has 63,522 respondents. My data includes only the samples of 34,315 respondents who are between 18 to 69 years of ages. Older people aged 70 and above and children lower than 18 are excluded as they do not have the control over BMI due to their consumption habit of fruits and vegetables and their physical activity.

BMI less than 60 is the dependent variable, which is self-reported by the respondents. I select CCHS data 2014 of self-reported BMI rather than calculating by using weight in kilograms divided by height in meters squared. Different literatures are studied to select the potential determinants of BMI. The explanatory variables include fruits and vegetables (fv) consumption. This indicates the number of times per day the respondent consumes fv, not the amount consumed. Physical activity - a lifestyle variable - is another determinant of BMI for which I select continuous data. This classification is based on the monthly frequency on leisure-time physical activities which lasts more than 15 minutes. Other socio-demographic and life-style variables are also included in the study. Gender is considered as dummy variable as female=1 and male=0. Age is represented in three categories – 18 to 34 (age0) as the reference group, 35 to 54 (age1) and 55 to 69 (age2). Educational attainment is represented by four dummy variables – less than secondary (edu0) as the reference group, secondary (edu1), some post-secondary (edu2) and post-secondary (edu3). Three dummy variables represent marital status of the respondents – married and common law (partner), widowed, separated, and divorced (WSD), and single as the reference group. Immigration status of the respondents is classified as immigrant (IMM=1) and non-immigrant (NIMM=0). Three dummy categories classify smoking status as: current smoker (csmoker), former smoker (fsmoker), and never smoker (nsmoker) as the reference group. Households income is classified in three dummy categories: less than $20,000 (income0) as the reference group, $20,000 to less than $60,000 and $60,000 to $80,000 and more. Provincial effects are categorized in 5 parts: Ontario (ON); British Columbia (BC); Quebec; Atlantic comprising Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick as the reference group, and Western consisting of Manitoba, Saskatchewan, and Alberta.

BACKGROUND INFORMATION

OLS

The method of ordinary least squares (OLS) is attributed to Carl Friedrich Gauss, a German mathematician. OLS is the most widely used estimation procedure to find out the average behavior of outcome variable dependent on some regressors based on the conditional mean function $E(y|X)$. For linear regression model, the relationship of dependency between variables is described properly by the OLS estimation procedure. A simple linear regression model can be

$$Y_i = \beta_1 + \beta_2 X_i + \varepsilon_i$$

Here Y is the dependent variable, X is the explanatory variable for i = 2,….,n, and ε is the disturbance term. So, the disturbance term can be

$$\varepsilon_i = Y_i - \beta_1 - \beta_2 X_i$$

And the estimated error term will be

$$e_i = y_i - b_1 - b_2 X_i$$

which shows that e (the residual) is simply the differences between the actual (y_i) and estimated Y values ($b_1 + b_2 X_i$). If we try to summarize the residuals, all the residuals get same weight in the summation no matter how close or far each are from the regression function and the sum becomes near to zero. To overcome this problem, we use OLS which adds the squared residuals and find out the minimum sum of squared residuals. In other words, OLS coefficient minimizes the sum of squares of the residuals.

$$\sum e_i^2 = \sum (y_i - b_1 - b_2 X_i)^2$$

This method gives same weight to the residuals, whether it is close or far from the regression line. OLS estimators are completely based on the sample, thus it is observable and easy to compute. Linear least squares is appropriate for only the linear models not for non-linear ones. For non-linear models. it will provide biased and inconsistent result.

In this study, I have used BMI as the dependent variable and life style variables like fv consumption, physical activity, some variables showing SES and socio-demographic condition of the respondents as the independent variables. The relationship between BMI and the variables may be non-linear which can make OLS results biased. Still I have used OLS to compare my prediction with the method.

Ramsey RESET test

A functional form misspecification usually means that the model does not consider some important nonlinearities, and omitting important variables is also a kind of misspecification. The Ramsey RESET test could be a way to test whether there are any significant non-linear relationships persisting in a linear regression model. To check the correctness of my model, to detect omitted variables, and incorrect functional form, I have included Ramsey's RESET test which proceeds as follows:

Estimating the following model:

$$Y_i = \beta_1 + \beta_2 X_i + \varepsilon_i$$

The predicted value of y is

$$\hat{y} = b_1 + b_2 X_i$$

Testing the augmented model as

$$Y_i = \beta_1 + \beta_2 X_i + \gamma_1 \hat{y}^2 + \gamma_2 \hat{y}^3 + \varepsilon_i$$

Test for misspecification:

H_0: $\gamma_1 = \gamma_2 = 0$, against H_1: $\gamma_1 \neq \gamma_2 \neq 0$

Rejection of null hypothesis implies that the original model is not adequate and it can be improved either by including relevant omitted variables or by taking non-linear form - higher order, log form - of the important determining variables depending on the type of the model.

Chow test

Chow test can be used to determine whether multiple regression function differs across two groups (Woolridge, 2013). The relationship between dependent and explanatory variables may be different for different groups and the values of the parameters of the model may not remain same for the groups. Here I have used Chow test to find the rationality of running separate regression for two groups, male and female. To do that, the estimation procedure follows by

Male sample: $y_i = \gamma x + \varepsilon,\ n_1$

Female sample: $y_i = \delta x + \varepsilon,\ n_2$

Whole sample: $y_i = \beta x + \varepsilon,\ n = n_1 + n_2$

Model of whole sample is the restricted model and both male and female sample models are unrestricted models. Now we need to test for structural break as follows:

H_0 : $\gamma = \delta$ against H_1 : not all of those equal to each other

Rejecting the null satisfies that there is structural break in the model and either intercepts or slopes or both intercepts and slopes of the two regressions are different.

Quantile Regression Model

Most familiar measures used to describe a distribution are the mean for the central location and the standard deviation for the dispersion. For skewed distributions the mean and standard deviation are not the best measures of location and shape. Quantile estimation procedure can solve the problem of location and shape of asymmetric distribution (Hao and Naiman, 2007). The concept of quantile regression was first introduced by Koenker and Bassett (1978). They tried to overcome the limitations of standard estimation procedure by the new estimation procedure regression quantiles.

Quantile regression describes the relationship at different points in the conditional distribution of dependent variable. Equivalent to the conditional mean function of linear regression, we can consider the relationship between the explanatory variables and the outcome using the conditional median function $Q_q\,(y|X)$, where the median is the 50th percentile, or quantile q, of the empirical distribution. The quantile q ∈ (0,1) is that y, which splits the data into proportions q below and 1− q above: $F(y_q)$ = q and y_q= $F^{-1}(q)$: for the median, q = 0.5. $F(y_q)$ represents the cumulative distribution function (CDF) of y and y_q represents the qth quantile of outcome y conditional on X (Baum, 2013).

OLS minimizes the model prediction error $\sum e_i^2$, while quantile regression minimizes a sum that gives asymmetric penalties $(1-q)|e_i|$ for over prediction and $q|e_i|$ for under prediction.

Quantile regression estimator is asymptotically normally distributed. We can use quantile regression to model conditional quantiles of the joint distribution of y and x (Baum, 2013).

Let $\hat{y}\,(X)$ is the predictor function and $e(X) = \big(y - \hat{y}\,(X)\big)$ be the prediction error. Then $L\big(e(X)\big) = L\big(y - \hat{y}\,(X)\big)$ denotes the loss associated with the prediction error. If L(e) = |e|, the optimal predictor is the conditional median, $med(y|X)$, and the optimal predictor is that $\hat{\beta}$ which minimizes $\sum_i |y_i - X_i'\beta|$ (Baum, 2013).

The quantile regression estimator for quantile q minimizes the objective function

$$Q(\beta_q) = \sum_{i:y_i \geq X_i'\beta_q}^{N} q\,|\,y_i - X_i'\beta_q\,| + \sum_{i:y_i < X_i'\beta_q}^{N} (1-q)\,|\,y_i - X_i'\beta_q\,|$$

where 0< q <1.

Bootstrap standard errors are used for minimizing this non-differentiable function rather than standard analytical standard error (Baum, 2013).

The advantage of quantile regression is that if the errors are highly non-normal, OLS can be inefficient but quantile regression is more efficient in this case and it is robust for outliers. The CDF, $F(y_q)$, for BMI is illustrated in figure 2 and the inverse CDF, y_q, is illustrated in figure 3. Table 2 presents the level of BMI at different quantiles for male, female and whole sample.

Figure 2: CDF of BMI when BMI<60

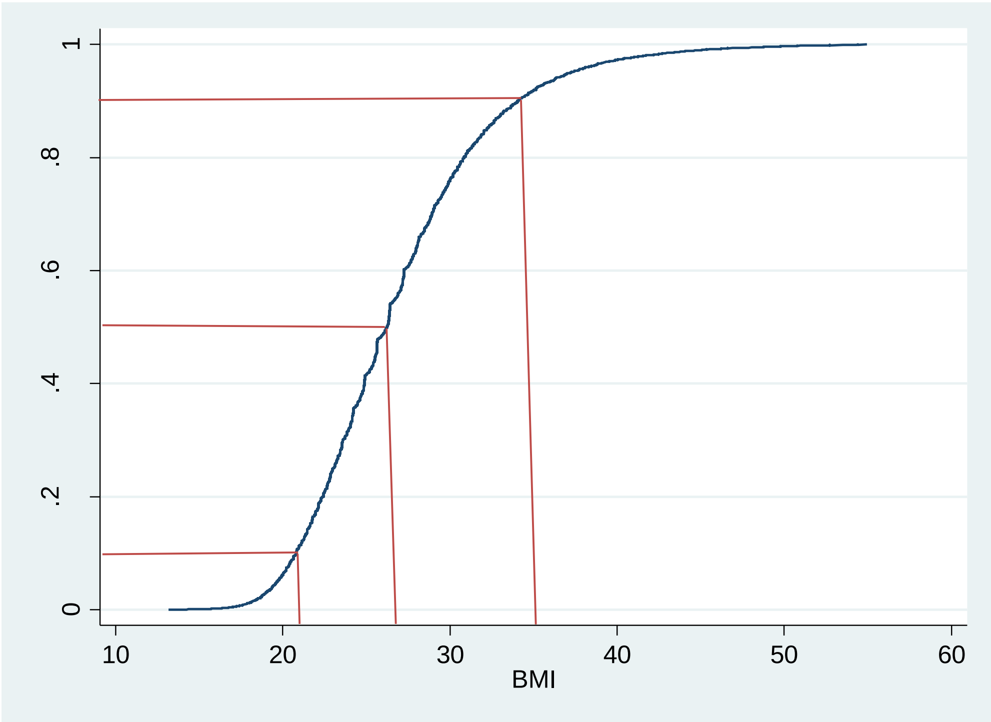


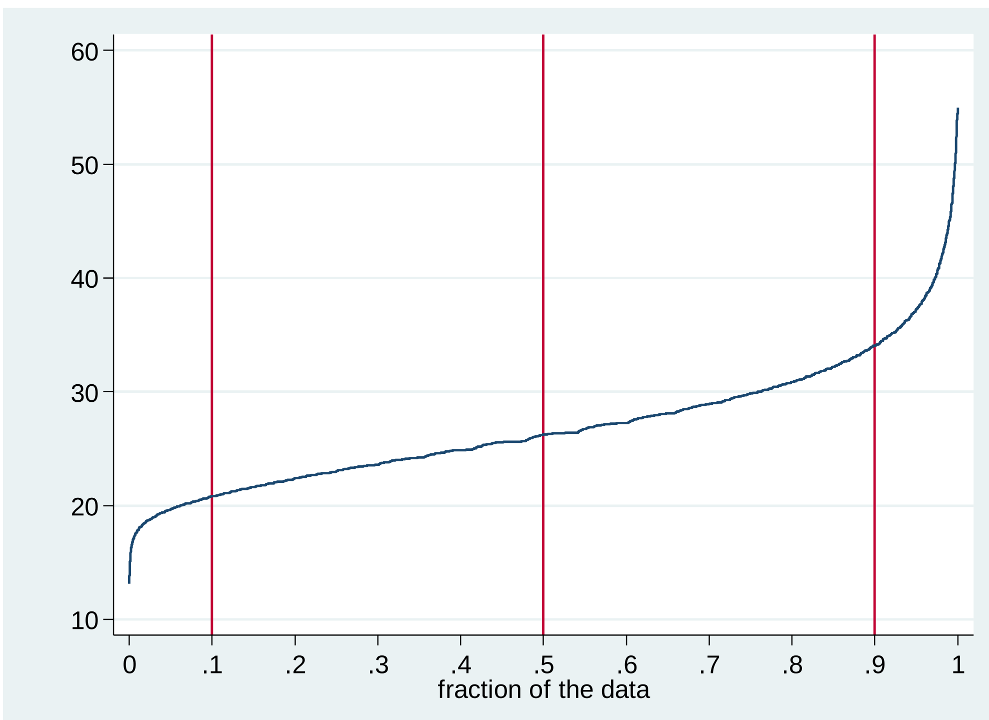
Table 2: Level of BMI at different quantiles for male, female and whole sample

Quantiles of BMI	Male	Female	Whole
Q 10	21.97	20.19	20.83
Q 20	23.49	21.59	22.43
Q 30	24.8	22.78	23.58
Q 40	25.63	24.03	24.89
Q 50	26.76	25.4	26.23
Q 60	27.9	26.91	27.25
Q 70	29.28	28.65	28.92
Q 80	30.94	30.76	30.84
Q 90	33.74	34.18	34.04

Source: Authors calculation

Cumulative distribution function ranges between 0 and 1. For the values of BMI lower than 60, CDF has a nice ‘S’ shape which shows that BMI probably lower than 18 has zero distribution and it is rising until somewhere below 50 and after that 100 percent of the distribution is between 50 to 56 BMI. In figure 3, we see the inverse CDF of BMI for different percentiles in different quantiles. The 10th, 50th and 90th quantiles are 20.83, 26.23, and 34.04. The reference lines give the quantiles of underweight, normal weight, overweight and obese. The graph shows that majority of the sample is in between normal and overweight. The marginal effects of covariates on BMI are considered on different quantiles.

Figure 3: The empirical inverse CDF of BMI when BMI<60



METHODS

Different economic models are developed to analyze decisions associated with many economic problems. Consumption behavior of different individuals is explained and analyzed through the problem of utility maximization. All the economic agents always try to maximize their utility through their activities and behavior facing some kind of constraints which they take into account. Food consumption is the basic need for any individual and people try to maximize their utility by choosing optimum level of food consumption. Food consumption and body weight are related to economic decision and research on these topics are still going on vastly. Ruhm (2012) takes help from the behavioral economics associated with traditional economic theories to study the determining factors of individual weight. According to Ruhm (2012), 'The combination of economic and biological factors is likely to result in overeating, in the current environment of cheap and readily available food' (p: 2). He proposes a dual decision model which is characterized by overeating and excess weight. Azagba and Sharaf (2012) examines the relationship between fruits and vegetables consumption and BMI using quantile regression.

Research articles related to health commonly use multivariate regression techniques to measure the relationship of health outcomes with clinical characteristics, sociodemographic factors, socio-economic status (SES), life-style and policy changes (Le Cook and Manning, 2013). Following Azagba and Sharaf's (2012) model and the concept of overeating and excess weight of Ruhm (2012), I have included the life style and SES factors - fruits and vegetables consumption, physical activity, income, education and other - in my model to determine the relationship between BMI and these factors. To estimate this relationship, I have examined the following model at first:

Ordinary Least Squares (OLS)

$$BMI_j = \alpha + \beta fv_j + \mu phys\_act_j + \theta X_j + \varepsilon$$

Where j denotes individual associated with province of residence. BMI represents an individual's reported Body Mass Index. fv denotes the frequency of fruits and vegetables consumption, phys_act denotes monthly physical activity of individuals, and X is a vector of other regressors. ε is the disturbance term which remains constant for every individual and province of residence.

Ramsey RESET test

Ramsey RESET test is designed to detect omitted variables and incorrect functional form of a model. To determine the nonlinearity of the basic model that I propose in this study, it is useful to test for misspecification of the model.

Model 1: $BMI_j = \beta_1 + \beta_2 fv_j + \beta_3 phys\_act_j + \varepsilon$

This is the linear basic model which I proceed with. Now I check the nonlinearity of the model that is whether the model has specification error or not. To do that I use Ramsey RESET test. To test for nonlinearity, I proceed through following

$$\widehat{BMI_j} = b_1 + b_2 fv_j + b_3 phys\_act_j$$

$$BMI = \beta_1 + \beta_2 fv + \beta_3 phys_{act} + \gamma_1 \widehat{BMI}^2 + \gamma_2 \widehat{BMI}^3 + \gamma_3 \widehat{BMI}^4 + e$$

To test this model, I have a null and alternative hypothesis.

H_0: $\gamma_1 = \gamma_2 = \gamma_3 = 0$, against

H_1: At least one of this is not equal to zero

This is equivalent to test between:

H_0: The model is adequate

H_1: The model is not adequate

F-test is used to test the hypothesis.

$$F = \frac{(SSE_R - SSE_{UR})/j}{SSE_{UR}/(n-k)}$$

Rejecting the null concludes that the model is not adequate and there is a way to improve the model.

Firstly, the RESET test is done for the linear regression function to test whether the model can be improved or not and then we add quadratic term in the model to test the possible non-linearity of the model. I have added second order higher terms for fv and physic_act with the basic model. The determinants of BMI are then fv, physic_act, fv^2 and $phys\_act^2$.

Model 2: $BMI_j = \beta_1 + \beta_2 fv_j + \beta_3 phys\_act_j + \beta_4 fv^2 + \beta_5 phys\_act^2 + \varepsilon$

$$\widehat{BMI_j} = b_1 + b_2 fv_j + b_3 phys\_act_j + b_4 fv^2 + b_5 phys\_act^2$$

I carry on the same procedure as model 1.

$$BMI = \beta_1 + \beta_2 fv + \beta_3 phys_{act} + \beta_4 fv^2 + \beta_5 {phys_{act}}^2 + \gamma_1 \widehat{BMI}^2 + \gamma_2 \widehat{BMI}^3 + \gamma_3 \widehat{BMI}^4 + u$$

The testing procedure follows the same as before.

H_0: $\gamma_1 = \gamma_2 = \gamma_3 = 0$, against

H_1: At least one of this is not equal to zero

This is equivalent to test between:

H_0: The model is adequate

H_1: The model is not adequate

Rejecting a null hypothesis of $\gamma_1 = \gamma_2 = \gamma_3 = 0$ states that the model has nonlinearity and it can be improved.

F-test is used to test the hypothesis.

$$F = \frac{(SSE_R - SSE_{UR})/j}{SSE_{UR}/(n-k)}$$

Chow test

The Chow Test inspects whether parameters (slopes and the intercept) of one group are different from those of other groups, but it does not explicitly tell us which coefficient, intercept or slope, is different or whether both are different in the two groups.

Restricted model:

$$BMI_j = \alpha_1 + \alpha_2 fv_j + \alpha_3 phys\_act_j + \alpha_k X_j + \varepsilon$$

And unrestricted models:

$$BMI_{mj} = \gamma_1 + \gamma_2 fv_{mj} + \gamma_3 phys\_act_{mj} + \gamma_k X_{mj} + \varepsilon$$

$$BMI_{fj} = \delta_1 + \delta_2 fv_{fj} + \delta_3 phys\_act_{fj} + \delta_k X_{fj} + \varepsilon$$

The first model is for male and second one is for female. Now we test

$H_0 : \gamma = \delta$ against H_1 : not all of those equal to each other

Which is equivalent to testing:

H_0: There is no structural break

against

H_1: There is structural break

The F-statistic is used to test the hypotheses.

$$F = \frac{(SSE_R - SSE_{UR})/K}{SSE_{UR}/(n - 2K)}$$

Rejecting the null concludes that the two models do not have same parameters (slopes or intercepts or both), thus there is structural break between the models.

Quantile regression model

$$Q_{BMI}\,(q|fv_j, phys\_act_j, X_j) = \alpha(q) + \beta(q)fv_j + \mu(q)phys\_act_j + \theta(q)X_j + \varepsilon_j^q$$

Q represents qth conditional quantile for BMI given fv, physic_act and X is Q_{BMI}. The coefficients find out the heterogeneous association between BMI and explanatory variables along the different points in the conditional distribution. ε_j^q represents the disturbance term varying with the different values of quantile. A quantile regression parameter illustrates that a one unit change in the regressor at a specific quantile, produces a change in the conditional quantile of BMI, the dependent variable.

RESULTS

Ramsey RESET test

When the relationship between the dependent and observed explanatory variables is not properly specified, the problem of functional form misspecification arises. This leads to biased and inconsistent estimator. So before proceed through the estimation procedure, it is necessary to be sure about choosing the correct model and estimation technique. To do that I run OLS at first for different models with and without quadratic term, and with only some limited explanatory variables, and then, I check the Ramsey RESET test.

For model 1, which I discussed in methods part, I have got the estimated values by running OLS.

$$\begin{array}{lccccc} \hat{BMI} & = & 28.325 & - & 0.140 fv - & 0.026 phys\_act \\ p-value & & (0.000) & & (0.000) & (0.000) \end{array}$$

Now Ramsey RESET test is conducted through the procedure described in methods section where the null hypothesis is ‘The model is adequate’ against the alternative of ‘The model is not adequate’. Rejecting the null ensures that the model is inadequate to analyze the true situation and it can be modified.

F-statistic = 20.04 and p-value = 0.0000 and Adjusted R^2 = 0.0221

F-value is large and p-value is zero, well below the level of significance (0.01, 0.05 and 0.10), which indicates that we reject the null hypothesis and concludes that our original model is inadequate and it can be improved. To improve the model, two quadratic explanatory variables fv^2 and $phys\_act^2$ are included with fv and physical activity into model 2 to determine the omission of nonlinearity.

The estimated values for model 2, again, which I discussed in methods section, by running OLS are

$$\begin{array}{lllllll} \hat{BMI} & = 28.670 & -0.182fv - & 0.045phys\_act & +0.0035fv^2 & +0.0002phys\_act^2 \\ p-value & (0.000) & (0.000) & (0.000) & (0.053) & (0.000) \end{array}$$

Using the similar procedure of model 1, described before, I measure the value of F-statistic and p-value which are

F-statistic = 1.84 and p-value = 0.1378 and Adjusted R^2 = 0.0241

This model shows improvement, F-value decreases substantially and p-value rises enough to reach higher than all - 1%, 5%, and 10% - the level of significance (α) and also reaches the decision of non-rejection. So, we cannot reject the null hypothesis and can conclude that the model is adequate to get the expected outcome.

For this model, as we cannot reject the null, the simple nonlinear model outperforms the linear model. The simple nonlinear regression model still not flexible enough. In order to get the complete picture of the association of the key variables with BMI we use a different estimation technique - quantile regression.

Chow test

Chow test is based on the OLS regression when we try to pool two or more groups together and try to interpret those groups as one which is mostly unrealistic. In this study, I have a huge amount of data which may help to run the regression separately for female and male. Pooling data for both groups may provide good result but may not be appropriate. So, I conducted Chow test to provide the rationality of running regression separately for female and male. As I have mentioned earlier, pooled sample model is restricted model, and male and female are unrestricted ones.

SSE_R = 980234.317

$SSE_{UR} = SSE_m + SSE_f$ = 965214.04

$F_{(18,\ 34279)} = \frac{(SSE_R - SSE_{UR})/K}{SSE_{UR}/(n-2K)}$ = 29.63

$F_c\ (18, 34279) \approx 1.88$ at $\alpha = .01$. So we reject the null hypothesis and can conclude that there is structural break between these two groups and we should run regression separately.

Summary statistics

Table 3 represents the descriptive summary of the variables for whole sample, and table 4 and 5 summarizes the mean and standard deviation of the variables for male and female, respectively. The mean BMI is 26.94, means that on average, the study group of people are little overweight. BMI is categorized in underweight (18.5 or less), acceptable or normal weight (18.6 to 24.9), overweight (25 to 29.9) and obese (30 or more) (Statistics Canada[4], Health reports 1999). Males have relatively higher BMI on average (27.47) than females (26.49). Both of the groups are overweight on average. The average number of fv intake is 4.63 which is little below the recommended number, 5 times a day. Females consume 5 times per day on average whereas males consume on average only 4 times per day. On an average, the respondents' monthly frequency of physical activity is 28.42 times. Males frequency of physical activity is little higher than that of females. Among the study population, 46% are male and 54% are female. 35% of the respondents are ages between 35 and 54. In term of educational level attainment, almost 63% of the target population have completed 1 or more post-secondary educations, and 11% have less than secondary education. Females achievements of higher education is more than that of males. Only 22% of the study population is currently smoker, whereas 44% are former smokers who have already quit smoking. Only 13% of the target population are immigrants, and 47% of the study population earns yearly income between 20 thousand to below 60 thousand dollars. Most of the respondents are the residents of Ontario, almost 33%.

Table 3: Summary Statistics of whole sample

Variables	**Mean**	**St. Deviation**
BMI	26.94	5.54
Fruits and vegetables (fv)	4.63	2.57
Physical_activity	28.41	25.30
Gender		
Male	.463	.499
Female	.537	.499
Age		
Age 18-34 (age0)	.238	.426
Age 35-54 (age1)	.345	.475
Age 55-69 (age2)	.418	.493
Marital Status		
Married (partner)	.578	.494
Separated (WSD)	.168	.374
Single	.254	.435
Education		
Lower than secondary (edu0)	.111	.314
Secondary (edu1)	.211	.408
Some post-secondary (edu2)	.052	.222
Post-secondary (edu3)	.626	.484
Immigration status		
Immigrants (IMM)	.134	.341
Non-immigrants (NIMM)	.866	.341
Smoking status		
Current smoker (csmoker)	.222	.416
Former smoker (fsmoker)	.437	.496
Never smoker (nsmoker)	.341	.474
Income level		
Income level<20 (income0)	.251	.434
Income level: 20 - <60 (income1)	.467	.499
Income level: >=60 (income2)	.281	.450
Province		
Ontario (ON)	.326	.469
Quebec	.203	.402
British Columbia (BC)	.124	.330

Atlantic	.134	.341
Western	.213	.409
Observations	**34,315**	

Weighted statistics using the CCHS sampling weights

Table 4: Summary Statistics of Male

Variables	**Mean**	**St. Deviation**
BMI	27.47	5.02
Fruits and vegetables (fv)	4.20	2.49
Physicl_activity	28.71	26.16
Age		
Age 18-34 (age0)	.249	.432
Age 35-54 (age1)	.347	.476
Age 55-69 (age2)	.405	.491
Marital Status		
Married (partner)	.584	.493
Separated (WSD)	.127	.333
Single	.290	.454
Education		
Lower than secondary (edu0)	.122	.328
Secondary (edu1)	.213	.409
Some post-secondary (edu2)	.054	.225
Post-secondary (edu3)	.612	.487
Immigration status		
Immigrants (IMM)	.136	.343
Non-immigrants (NIMM)	.864	.343
Smoking status		
Current smoker (csmoker)	.246	.431
Former smoker (fsmoker)	.455	.498
Never smoker (nsmoker)	.300	.458
Income level		
Income level<20 (income0)	.175	.380
Income level: 20 - <60 (income1)	.441	.496
Income level: >=60 (income2)	.384	.486
Province		
Ontario (ON)	.323	.467
Quebec	.199	.399
British Columbia (BC)	.128	.334
Atlantic	.130	.336
Western	.221	.415
Observations	**15,886**	

Weighted statistics using the CCHS sampling weights

Table 5: Summary Statistics of Female

Variables	**Mean**	**St. Deviation**
BMI	26.48	5.91
Fruits and vegetables (fv)	5.00	2.57
Physical_activity	28.16	24.53
Age		
Age 18-34 (age0)	.228	.420
Age 35-54 (age1)	.343	.475
Age 55-69 (age2)	.429	.495
Marital Status		
Married (partner)	.573	.495
Separated (WSD)	.204	.403
Single	.223	.416
Education		
Lower than secondary (edu0)	.101	.302
Secondary (edu1)	.209	.407
Some post-secondary (edu2)	.051	.220
Post-secondary (edu3)	.639	.480
Immigration status		
Immigrants (IMM)	.133	.340
Non-immigrants (NIMM)	.867	.340
Smoking status		
Current smoker (csmoker)	.202	.401
Former smoker (fsmoker)	.422	.494
Never smoker (nsmoker)	.376	.484
Income level		
Income level<20 (income0)	.317	.465
Income level: 20 - <60 (income1)	.491	.500
Income level: >=60 (income2)	.192	.394
Province		
Ontario (ON)	.328	.470
Quebec	.207	.405
British Columbia (BC)	.122	.327
Atlantic	.138	.345
Western	.206	.404
Observations	**18,429**	

Weighted statistics using the CCHS sampling weights

OLS and Quantile regression

The OLS estimates and the quantile regression for BMI of the whole sample are illustrated in table 6 for some selected quantiles between 10th and 90th BMI distribution. Analyzing the results of OLS, we see a negative relationship between fv and BMI, and physical activity and BMI which are consistent with our expectation. These can be interpreted as, increase in one serving of fv per day will lower BMI by .081 point, on average, and lowering monthly physical activity one time will increase the chance of getting higher BMI by .025 point, on average. Both of these are statistically significant that is these are statistically different than zero.

Table 6: OLS and Quantile results of BMI determinants for selected quantiles- Whole Sample

Variables	OLS	Quantile Regression estimates				
		10	30	50	70	90
fv	-.109***	-.103***	-.108***	-.115***	-.113***	-.119***
	(.012)	(.012)	(.014)	(.014)	(.014)	(.029)
Physical_activity	-.026***	-.005***	-.013***	-.019***	-.030***	-.045***
	(.001)	(.001)	(.001)	(.001)	(.002)	(.004)
Age						
Age1 (35-54)	1.589***	.915***	1.359***	1.537***	1.576***	1.613***
	(.084)	(.089)	(.093)	(.114)	(.096)	(.219)
Age2 (55-69)	1.671***	1.384***	1.862***	1.852***	1.592***	1.04***
	(.085)	(.080)	(.082)	(.121)	(.118)	(.146)
Marital Status						
Partner	.101	.442***	.411***	.432***	.205**	-.652***
	(.076)	(.078)	(.060)	(.085)	(.100)	(.245)
WSD	.092	.069	.007	.225*	.324**	.109
	(.100)	(.098)	(.074)	(.131)	(.145)	(.291)
Education						
edu1 (Secondary)	-.468***	-.046	-.415***	-.426***	-.735***	-.872***
	(.109)	(.125)	(.113)	(.100)	(.124)	(.266)
edu2 (Some post-	-.553**	-.196	-.560***	-.737***	-.895***	-.468
secondary)	(.156)	(.188)	(.174)	(.207)	(.318)	(.519)
edu3 (Post-	-.849***	-.421***	-.896***	-.884***	-1.104***	-1.135***
secondary)	(.099)	(.111)	(.110)	(.102)	(.152)	(.326)
Immigration status						

IMM	-1.341***	-.625***	-.763***	-.967***	-1.442***	-2.311***
	(.088)	(.074)	(.082)	(.085)	(.092)	(.217)
Smoking status						
csmoker	-.675***	-.230**	-.467***	-.452***	-.597***	-.998***
	(.082)	(.093)	(.071)	(.081)	(.123)	(.256)
fsmoker	.591***	.629***	.609***	.609***	.626***	.629***
	(.068)	(.082)	(.074)	(.072)	(.121)	(.177)
Income level						
income1 (Income	.118	.691***	.464***	.225***	.040	-.753***
level (20 - <60))	(.074)	(.092)	(.080)	(.071)	(.10)	(.180)
Income2 (Income	.322***	1.201***	1.041***	.711***	.183*	-1.097***
level(=>60))	(.086)	(.089)	(.086)	(.089)	(.094)	(.193)
Province						
ON	-.430***	-.423***	-.482***	-.390***	-.475***	-.171
	(.095)	(.100)	(.121)	(.144)	(.157)	(.246)
Quebec	-1.423***	-.945***	-1.148***	-1.249***	-1.487***	-1.684***
	(.103)	(.108)	(.108)	(.139)	(.147)	(.316)
BC	-1.129***	-.633***	-1.004***	-1.085***	-1.270***	-1.119***
	(.116)	(.099)	(.125)	(.136)	(.169)	(.300)
Western	-.212**	-.441***	-.421***	-.242*	-.137	.429
	(.102)	(.087)	(.110)	(.126)	(.127)	(.306)
Observations				**34,315**		

Standard errors are in parentheses. p<0.01***, p<0.05** and p<0.10*
Authors estimation using the CCHS sampling weights

The coefficient of fv and physical activity vary across quantiles of the conditional BMI distribution as quantile regression helps us to examine the heterogeneous responses of individual's BMI to the explanatory variables at different tails of the distribution (Azagba and Sharaf, 2012). The marginal effects of frequency of fv intake and monthly leisure time physical activity on BMI increase for individuals in the higher quantile. For example, the coefficient of fv at the 90th quantile is almost three times the estimate at the 10th quantile. For physical activity it is almost 4 times in 90th quantile than in 30th quantile. Moreover, in lower quantiles, the decrease in BMI brought by fv consumption and leisure time physical activity is lower compared to the conditional mean estimates. The reason of getting these kind of estimated values can be the consumption of fv may be an effective factor to control over excessive weight and actively engagement in physical activities may help people to get rid of excess weight and reduce the risk of obesity.

Figure 4 displays the OLS and quantile regression estimates over the entire BMI distribution for the determinants of BMI for the whole sample. The figure shows the substantial differences across the quantiles of the BMI distribution. The vertical axis gives the values of estimated coefficient while the horizontal axis gives the quantiles of that variable. The horizontal bolded solid line gives the estimated coefficient of OLS regression, and the dotted lines below and above the solid line, represents the corresponding confidence intervals. The OLS regression coefficients are different for different variables but it remains same across quantiles. However, coefficients of quantile regression are plotted as lines varying across the quantiles. These shaded lines of quantile regression coefficients show the nonlinear association between BMI and the studied explanatory variables. For physical activity, all the coefficients are negative both for OLS and quantile regression, which shows the negative impact of physical activity on BMI. As all the coefficients are well below zero these are statistically different from zero. Age has a positive relationship with BMI showing that the older people have higher BMI than the younger ones. Considering income estimates, increasing in income lowers BMI but it is not always significant, meaning that it has lower impact on determining the BMI level. Higher level of education lowers BMI maybe because well educated people are more concerned about their health status. Current smokers, and immigrants have negative association with BMI whereas former smokers, married and separated people have positive and more or less statistically significant impact on BMI.

Table 7 and 8 report the quantile regression and OLS results for female and male respectively. Figure 5 shows the level of BMI across different quantiles of distribution for male, female and whole sample and polynomial trend of whole sample. The estimates for fv and physical activity for both male and female shows almost similar pattern as the whole sample shown in table 6. Nonetheless all the coefficients are statistically significant. Other covariates are quite similar to the whole sample except married female have negative association with BMI for 50th, 70th and 90th quantiles and married male has all the positive association except in 90th quantile. Another exception is related to the socio-economic status – education and income. The association of income and BMI is positive and most are statistically significant for males, and the association is negative in most of the quantiles and only a few are statistically significant for females.

Figure 4: OLS and quantile regression estimates for BMI determinants-whole sample

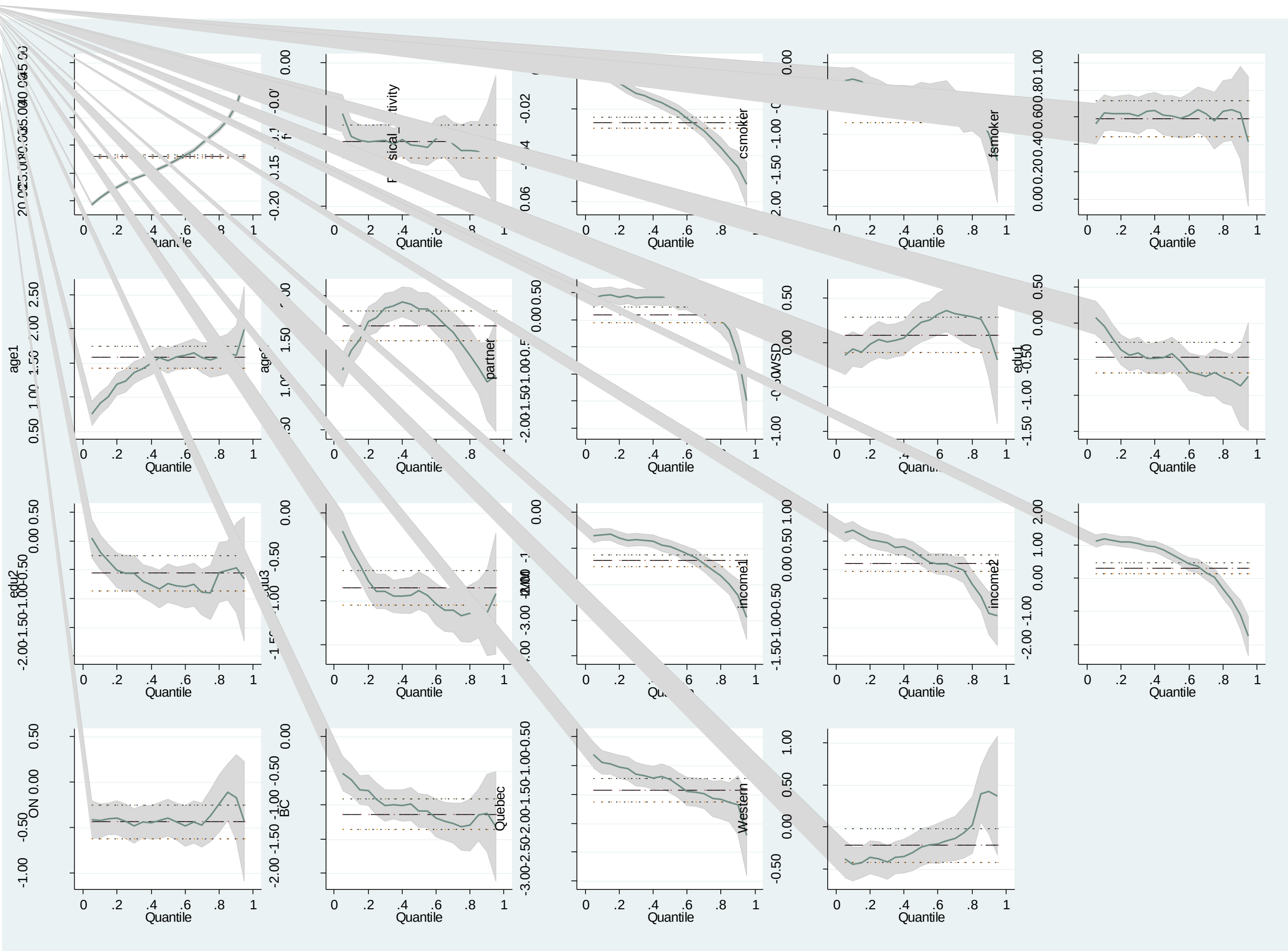


Table 7: OLS and Quantile results of BMI determinants for selected quantiles- female

Variables	OLS	Quantile Regression estimates				
		10	30	50	70	90
fv	-.063*** (.017)	-.038*** (.014)	-.041*** (.015)	-.041** (.018)	-.059** (.024)	-.119*** (.034)
Physical_activity	-.038*** (.002)	-.008*** (.001)	-.020*** (.001)	-.033*** (.002)	-.047*** (.002)	-.061*** (.004)
Age						
Age1 (35-54)	1.792*** (.122)	.960*** (.094)	1.341*** (.105)	1.910*** (.117)	2.118*** (.198)	1.840*** (.299)
Age2 (55-69)	1.943*** (.123)	1.414*** (.106)	2.007*** (.141)	2.481*** (.134)	2.157*** (.218)	1.095*** (.309)
Marital Status						

Partner	-.241**	.421***	.411***	-.107	-.399***	-1.148***
	(.112)	(.097)	(.112)	(.156)	(.151)	(.308)
WSD	-.023	.276**	.315**	.184	.111	-.165
	(.142)	(.131)	(.141)	(.159)	(.176)	(.381)
Education						
edu1 (Secondary)	-.290*	.103	-.470***	-.365*	-.554***	.091
	(.164)	(.135)	(.169)	(.196)	(.205)	(.379)
edu2 (Some post-secondary)	-.366 (.232)	-.301 (.222)	-.686*** (.241)	-.734** (.285)	-.491 (.346)	.651 (.527)
edu3 (Post-secondary)	-.640*** (.152)	-.226* (.130)	-.855*** (.203)_	-.743** (.206)	-.929*** (.199)	-.563 (.389)
Immigration status						
IMM	-1.326***	-.574***	-.736***	-.817***	-1.307***	-2.438***
	(.129)	(.121)	(.107)	(.138)	(.128)	(.232)
Smoking status						
csmoker	-.445***	-.495***	-.307***	-.141	-.286*	-.636**
	(.121)	(.096)	(.115)	(.120)	(.173)	(.255)
fsmoker	.738***	.437***	.575***	.789***	.886***	.786***
	(.097)	(.069)	(.114)	(.122)	(.137)	(.250)
Income level						
income1 (Income level (20 - <60))	-.178* (.100)	.232*** (.080)	.033 (.097)	-.258* (.150)	-.191 (.146)	-.798*** (.275)
Income2 (Income level(=>60))	-.676*** (.131)	.046 (.131)	-.299** (.149)	-.587*** (.194)	-.819*** (.132)	-1.731*** (.249)
Province						
ON	-.577***	-.301***	-.582***	-.583***	-.522***	-.327
	(.137)	(.151)	(.141)	(.163)	(.170)	(.275)
Quebec	-1.919***	.781***	-1.449***	-1.745***	-2.006***	-2.602***
	(.147)	(.151)	(.167)	(.143)	(.224)	(.319)
BC	-1.326***	.573***	-1.138***	-1.401***	-1.580***	-1.369***
	(.168)	(.166)	(.147)	(.184)	(.175)	(.328)
Western	-.323**	-.273*	-.571***	-.446**	-.192	.181
	(.147)	(.162)	(.219)	(.214)	(.260)	(.272)
Observations			**18,429**			

Standard errors are in parentheses. p<0.01***, p<0.05** and p<0.10*
Authors estimation using the CCHS sampling weights

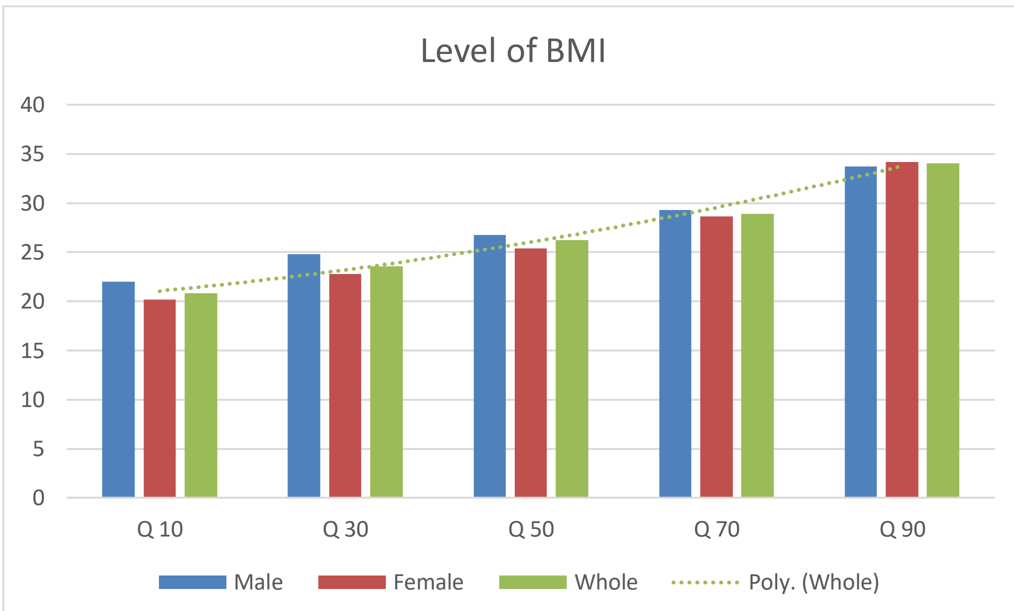
Table 8: OLS and Quantile results of BMI determinants for selected quantiles- male

Variables	OLS	Quantile Regression estimates				
		10	30	50	70	90
fv	-.080***	-.021	-.068***	-.084***	-.104***	-.116**
	(.016)	(.017)	(.017)	(.017)	(.024)	(.046)
Physical_activity	-.015***	.0006	-.003***	-.011***	-.020***	-.032***
	(.002)	(.001)	(.0009)	(.001)	(.002)	(.003)
Age						
Age1 (35-54)	1.514***	1.176***	1.328***	1.279***	1.296***	1.288***
	(.111)	(.133)	(.107)	(.116)	(.174)	(.317)
Age2 (55-69)	1.40***	1.281***	1.376***	1.306***	1.198***	.965**
	(.114)	(.120)	(.100)	(.107)	(.165)	(.379)
Marital Status						
Partner	.554***	.707***	.830***	.875***	.666***	-.015
	(.102)	(.105)	(.115)	(.103)	(.138)	(.252)
WSD	.482***	.391*	.539***	.726***	.772***	-.091
	(.142)	(.201)	(.171)	(.156)	(.196)	(.410)
Education						
edu1 (Secondary)	-.521***	-.030	-.170	-.366**	-.746***	-1.594***
	(.140)	(.234)	(.161)	(.181)	(.240)	(.460)
edu2 (Some post-	-.631***	-.005	-.257*	-.777***	-.993**	-1.238*
secondary)	(.202)	(.230)	(.140)	(.194)	(.386)	(.708)
edu3 (Post-	-.755***	-.160	-.385***	-.633***	-1.013***	-1.555***
secondary)	(.126)	(.200)	(.090)	(.141)	(.181)	(.368)
Immigration status						
IMM	-1.444***	-.959***	-.954***	-1.151***	-1.546***	-2.096***
	(.115)	(.125)	(.122)	(.134)	(.172)	(.368)
Smoking status						
csmoker	-1.105***	-.450***	-.839***	-.888***	-1.056***	-1.336***
	(.108)	(.109)	(.114)	(.132)	(.172)	(.351)
fsmoker	.261***	.493***	.366***	.286**	.179	.404
	(.094)	(.093)	(.091)	(.119)	(.171)	(.287)
Income level						
income1 (Income	.291**	1.101***	.660***	.365**	.018	-.674***
level (20 - <60))	(.113)	(.161)	(.066)	(.102)	(.116)	(.256)
Income2 (Income	.516***	1.679***	1.067***	.646***	.249*	-.822***
level(=>60))	(.125)	(.170)	(.084)	(.108)	(.136)	(.290)
Province						
ON	-.204	-.228*	-.177	-.102	-.279*	-.250
	(.128)	(.120)	(.136)	(.131)	(.150)	(.293)
Quebec	-.876***	-.787***	-.625***	-.706***	-1.086***	-.799**
	(.138)	(.111)	(.122)	(.142)	(.153)	(.401)

BC	-.887***	-.638***	-.756***	-.724***	-.993***	-.572
	(.154)	(.147)	(.156)	(.148)	(.222)	(.372)
Western	.013	-.133	-.168*	.038	.032	.901***
	(.137)	(.125)	(.100)	(.142)	(.190)	(.210)
Observations				**15,886**		

Standard errors are in parentheses. p<0.01***, p<0.05** and p<0.10*
Authors estimation using the CCHS sampling weights

Figure 5: Level of BMI with polynomial trend for whole sample in different quantiles



Authors calculation using CCHS 2014 data

DISCUSSION

Canada is one of the first countries to adopt body mass index (BMI) as a useful surrogate anthropometric measure of obesity (Lau, 2007). Emerging estimates of the direct cost - health care, and indirect costs of physical inactivity - loss of economic output due to illness, disease-related work disabilities or premature death - are alarming (WHO). The problem of prevalence of overweight and obesity is very concerning all over the world because obesity is advancing towards children and adolescents along with adults.

Over the past century, life expectancy at birth in Canada has risen substantially to 79.8 years for males, and 83.9 years for females (Statistics Canada[2]). Increases in the quantity of life cannot say a lot about the quality of life (Statistics Canada[3]). Quality of life is associated with healthy lifestyle which can face potential risk in the presence of overweight or obesity. BMI is associated with food habit, lifestyle behavior - smoking and physical activity, and socio-economic status – income, education.

'Eating and body weight are economic decisions, in that individuals presumably tradeoff the utility from current food intake against the associated monetary expense and disutility of future weight gains' (Ruhm, 2012, p: 1). When we consider losing weight or maintaining a healthy body weight, the concept of effective dietary strategies and adequate energy expenditure are raised despite physical, psychological, social and economic consequences. Therefore, the benefits of consuming fv and spending time on physical activities in weight management is undoubtable. In this study, I examine the association between the distributional attributes of BMI with the consumption of fv and energy expenditure through models under conditional mean framework and conditional quantile framework using the data from Canadian Community Health Survey 2014. Based on unconditional mean framework, I find that the daily average number of fv intake is little higher than 4 which is lower than the recommended amount of 5 servings per day. For the conditional mean framework, OLS, results show that the conditional mean of BMI is negatively and significantly associated with fv consumption. The accuracy of some results of the conditional mean framework models are not always satisfactory. This kind of models are actually based on the linear relationships between the response variable and predictors. As the determinants are nonlinearly related to BMI, which I have proved by using RESET test, quantile regression technique is added to get this association that varies across the conditional BMI distribution. This is almost same for association between physical activity and the conditional BMI distribution. Regular physical activity improves the power of survival and helps the body to function well, which can improve quality of life (Lim and Taylor, 2005). The coefficients of physical activities both for males and females reveal similar patterns as the whole population estimates. The OLS model overstates the effect of fv consumption and physical activity on the BMI at the lower half and understates at the upper half of the conditional BMI distribution. This proves that conclusions of OLS that assumes uniform response across different quantiles may be misleading.

Results for the other BMI determinants as socio-economic status (SES), usually measured by income and education level, hugely affects the food habits of the individuals, hence affects BMI. The level of income affects the capability of having healthy and nutritious food through heavy financial support and it also gives adequate time to spend on physical activities. Educational attainment makes people more careful about choosing appropriate consumption habit and creates awareness of necessity for and benefits of physical activity. Several studies show that people with higher SES have healthier, nutritionally more balanced diets and are more physically active than those with lower SES (Lim and Taylor, 2005; Azagba and Sharaf, 2011). Existing literatures most of the cases implies a negative association between SES and BMI among females in developing countries, on the other hand, among males this association is less consistent (Sobal and Stunkard, 1989). However, I find a negative association between income and BMI, and education and BMI among females, and a relatively strong positive association between income and BMI among males.

Results of life-style variables such as smoking status significantly affects the BMI both for males and females. I find that smokers have lower BMI, while former smokers have relatively higher BMI compared to those who have never smoked. The general belief is that smoking cessation is associated with an increase in BMI (Munafò et. al., 2009). My result is consistent with this belief.

I find that immigrants have lower BMI than natives. On average, immigrants are less likely to be obese or overweight upon arrival in Canada (McDonald and Kennedy, 2005). This difference decreases overtime due to acculturation and get used to with new life style. Results show that BMI increases with age which is consistent with previous literature of Baum and Ruhm (2009). They predicted an annual increase in the BMI of 0.12 kilograms/squared meter.

This study has some strength. First, I examine the association among fv intake, physical activity and BMI using both conditional mean and conditional quantile framework. Moreover, I test for nonlinearity using RESET test before using quantile regression to make the strong baseline of estimating through quantile regression. In particular, nonlinear relationships are captured by quantile regression technique, thus provides a richer characterization of the data. Additionally, using bootstrap method provides consistency of the model. Second, as I have used Ramsey RESET test to find out the misspecification error, it provides a way to get the unbiased and consistent estimators. Third, I report multivariate association among BMI and other potential determining factors. This study gives attention to individuals at all segments of the BMI distribution.

There are some limitations in my study. First, I choose self-reported BMI rather than measured by using height and weight, which may cause some inaccuracy of data. There is a strong discrepancy between the data of self-reported obesity and measured obesity using height and weight. According to OECD, in 2015, self-reported fraction of over obese people in Canada was 52.4 whereas the measured fraction was 64.1. Second, as I have used cross-sectional data, it may not appropriately infer the causality. Third, due to data limitation, the consumption of fv is based on number of times per day rather than the quantity consumed.

CONCLUSION

From the view of policy making, public and socio-economic contexts, findings of this study recommend that policies strengthening the consumption of fv and activeness in physically may help to control over gaining more weight, and lead a healthy and happy life. The high obesity rate in Canada, and the rising risk of having unhealthy and unhappy life, give the scope to build an appropriate policy aimed to mitigate this problem. Effective dietary policy by increasing the frequency of fv consumption and encouraging physically activeness through proper exercise method can control the higher risk of gaining more weight. Study results show that the standard models that assume same response across different quantiles of BMI distribution may produce misleading conclusion. Additionally, inclusion of different SES variables and life-style variables may lighten important differences in health outcomes.

Policy makers should give more attention to find out the potential factors that can be helpful to influence body weight. Policy making can be based on the studies that are already conducted and still waiting to come out. The study findings may serve as empirical evidence in helping policy making and considering the trade-off among factors that limit public to make healthier choice. Government may establish a proper tax credit system against physical activities for a specific part of the population. The policy makers may set a set of policies to aware people about the importance of eating fruits and vegetables and other healthy foods. The food processing industries and finished food product suppliers may label their product reporting the ingredients and food values consisting inside.

Understanding the association among fv intake, physical activity and BMI distribution, may help to implement the intervention measures targeted toward the most vulnerable groups – obese and overweight.

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APPENDICES

Appendix 1

A. OLS results for whole sample

Source	SS	df	MS
Model	72219.0657	18	4012.17032
Residual	980234.317	34,296	28.5815931
Total	1052453.38	34,314	30.6712532

Number of obs = 34,315
F(18, 34296) = 140.38
Prob > F = 0.0000
R-squared = 0.0686
Adj R-squared = 0.0681
Root MSE = 5.3462

BMI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
fv	-.1091745	.0119213	-9.16	0.000	-.1325406	-.0858083
Phys_act	-.0258866	.0011977	-21.61	0.000	-.0282342	-.023539
csmoker	-.6745596	.0815273	-8.27	0.000	-.8343557	-.5147634
fsmoker	.5911015	.0682579	8.66	0.000	.4573137	.7248893
age1	1.589462	.0838947	18.95	0.000	1.425026	1.753899
age2	1.670864	.0849998	19.66	0.000	1.504261	1.837466
partner	.1013107	.0758378	1.34	0.182	-.0473339	.2499552
WSD	.0915811	.1002631	0.91	0.361	-.1049379	.2881001
edu1	-.4680604	.1089789	-4.29	0.000	-.6816627	-.2544582
edu2	-.5526684	.1558775	-3.55	0.000	-.8581935	-.2471433
edu3	-.8494778	.0993661	-8.55	0.000	-1.044239	-.654717
IMM	-1.341232	.0876942	-15.29	0.000	-1.513115	-1.169348
income1	.1182588	.0737182	1.60	0.109	-.0262314	.2627489
income2	.3215835	.0861814	3.73	0.000	.152665	.4905019
ON	-.4300202	.095209	-4.52	0.000	-.616633	-.2434074
BC	-1.12879	.1156912	-9.76	0.000	-1.355549	-.9020318
Quebec	-1.422825	.1025434	-13.88	0.000	-1.623814	-1.221837
Western	-.2120357	.1019694	-2.08	0.038	-.4118992	-.0121722
_cons	28.064	.1483258	189.21	0.000	27.77328	28.35472

B. OLS results for male

Source	SS	df	MS
Model	28713.0647	18	1595.17026
Residual	371769.681	15,867	23.43037

Number of obs = 15,886
F(18, 15867) = 68.08
Prob > F = 0.0000
R-squared = 0.0717

				Adj R-squared = 0.0706
Total	400482.746	15,885	25.2113784	Root MSE = 4.8405

BMI	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
fv	-.0793026	.0163011	-4.86	0.000	-.1112546	-.0473506
Phys_act	-.0150539	.0015461	-9.74	0.000	-.0180845	-.0120233
csmoker	-1.104674	.1075511	-10.27	0.000	-1.315486	-.8938616
fsmoker	.26146	.0936348	2.79	0.005	.0779251	.4449948
age1	1.514162	.1113293	13.60	0.000	1.295944	1.73238
age2	1.399565	.1137863	12.30	0.000	1.176531	1.622599
partner	.5535034	.1016599	5.44	0.000	.3542384	.7527685
WSD	.4819014	.1419102	3.40	0.001	.2037413	.7600615
edu1	-.5205798	.1401804	-3.71	0.000	-.7953493	-.2458103
edu2	-.6305994	.2023815	-3.12	0.002	-1.02729	-.2339087
edu3	-.755036	.1260755	-5.99	0.000	-1.002158	-.5079137
IMM	-1.444456	.1153822	-12.52	0.000	-1.670618	-1.218294
income1	.2911995	.1134314	2.57	0.010	.068861	.5135379
income2	.5164189	.1254286	4.12	0.000	.2705647	.7622732
ON	-.2038766	.128103	-1.59	0.112	-.4549729	.0472197
BC	-.8873437	.1538969	-5.77	0.000	-1.188999	-.5856884
Quebec	-.8757849	.1382889	-6.33	0.000	-1.146847	-.604723
Western	-.0131656	.1368395	-0.10	0.923	-.2813865	.2550553
_cons	27.74427	.2005357	138.35	0.000	27.3512	28.13735

C. OLS results for female

Source	SS	df	MS	
				Number of obs = 18,429
				F(18, 18410) = 86.72
Model	50315.4103	18	2795.30057	Prob > F = 0.0000
Residual	593444.359	18,410	32.2348918	R-squared = 0.0782
				Adj R-squared = 0.0773
Total	643759.769	18,428	34.9337839	Root MSE = 5.6776

BMI	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
fv	-.0632486	.0173822	-3.64	0.000	-.0973194	-.0291779
Physical_activity	-.0382477	.0017911	-21.35	0.000	-.0417583	-.0347371
csmoker	-.4446228	.1206581	-3.68	0.000	-.681124	-.2081216
fsmoker	.7384387	.0973318	7.59	0.000	.5476594	.9292181
age1	1.79243	.1222357	14.66	0.000	1.552837	2.032023
age2	1.942743	.1231819	15.77	0.000	1.701295	2.184191

partner	-.2407644	.1123667	-2.14	0.032	-.4610136	-.0205152
WSD	.022885	.1422561	0.16	0.872	-.2559501	.3017202
edu1	-.2895091	.1640209	-1.77	0.078	-.6110053	.0319871
edu2	-.3656939	.2320811	-1.58	0.115	-.8205944	.0892066
edu3	-.6402146	.1523173	-4.20	0.000	-.9387706	-.3416586
IMM	-1.326298	.1290501	-10.28	0.000	-1.579248	-1.073348
income1	-.1778142	.0997807	-1.78	0.075	-.3733936	.0177653
income2	-.6764686	.1310835	-5.16	0.000	-.9334045	-.4195328
ON	-.5774292	.1368108	-4.22	0.000	-.8455911	-.3092673
BC	-1.32613	.1680398	-7.89	0.000	-1.655503	-.9967562
Quebec	-1.918689	.1470785	-13.05	0.000	-2.206977	-1.630401
Western	-.3234692	.1472121	-2.20	0.028	-.6120186	-.0349197
_cons	28.04086	.2164535	129.55	0.000	27.61659	28.46513

Appendix 2

A. Table of OLS for Ramsey RESET test – Model 1

Source	SS	df	MS
Model	23268.3343	2	11634.1672
Residual	1029185.05	34,312	29.9949011
Total	1049272.32	34,314	30.6712532

Number of obs = 34,315
F(2, 34312) = 387.87
Prob > F = 0.0000
R-squared = 0.0221
Adj R-squared = 0.0221
Root MSE = 5.4768

BMI	Coefficient	Std. Error	t	P>|t|	[95% Conf. Interval]	
fv	-.1403374	.0119466	-11.75	0.000	-.1637532	-.1169217
Phys_act	-.0257653	.0012115	-21.27	0.000	-.0281398	-.0233907
cons	28.32496	.0641358	441.64	0.000	28.19925	28.45067

B. Table of OLS for Ramsey RESET test – Model 2

Source	SS	df	MS
Model	25456.7967	4	6364.19917
Residual	1026996.59	34,310	29.9328646

Number of obs = 34,315
F(4, 34310) = 212.62
Prob > F = 0.0000
R-squared = 0.0242
Adj R-squared = 0.0241

Total	1052453.38	34,314	30.6712532			Root MSE =	5.4711

BMI	Coefficient	Std. Error	t	P>|t|	[95% Conf. Interval]	
fv	-.1823309	.0265662	-6.86	0.000	-.2344014	-.1302603
Phys_act	-.0452538	.0027333	-16.56	0.000	-.0506111	-.0398964
fv2	.0034809	.0017993	1.93	0.053	-.0000458	.0070076
Phys_act2	.0002108	.0000263	8.03	0.000	.0001594	.0002623
cons	28.67043	.0885525	323.77	0.000	28.49686	28.844

Appendix 3

A. Quantile results for whole sample

Number of obs = 34,315

.10 Pseudo R2 = 0.0395, .20 Pseudo R2 = 0.0455, .30 Pseudo R2 = 0.0461

.40 Pseudo R2 = 0.0454, .50 Pseudo R2 = 0.0429, .70 Pseudo R2 = 0.0393

.80 Pseudo R2 = 0.0399, .90 Pseudo R2 = 0.0434

BMI	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf. Interval]	
q10						
fv	-.1025097	.0115305	-8.89	0.000	-.1251098	-.0799096
Phys_act	-.005104	.0010557	-4.83	0.000	-.0071731	-.0030349
csmoker	-.2304953	.0931628	-2.47	0.013	-.4130975	-.0478931
fsmoker	.6287702	.0817904	7.69	0.000	.4684584	.789082
age1	.9149591	.0890905	10.27	0.000	.7403388	1.089579
age2	1.383921	.0795188	17.40	0.000	1.228062	1.539781
partner	.4423491	.0780058	5.67	0.000	.2894552	.595243
WSD	-.0691492	.0984428	-0.70	0.482	-.2621004	.1238021
edu1	-.046362	.1248359	-0.37	0.710	-.2910446	.1983206
edu2	-.1957209	.1880076	-1.04	0.298	-.564222	.1727803
edu3	-.4213825	.1114009	-3.78	0.000	-.639732	-.203033
IMM	-.6248614	.0741993	-8.42	0.000	-.7702944	-.4794283
income1	.6909673	.0919136	7.52	0.000	.5108137	.871121
income2	1.201163	.0894503	13.43	0.000	1.025837	1.376488

ON	-.4230214	.0999325	-4.23	0.000	-.6188925	-.2271504
BC	-.633299	.0990951	-6.39	0.000	-.8275287	-.4390693
Quebec	-.9447832	.1084943	-8.71	0.000	-1.157436	-.7321307
Western	-.4407262	.0865991	-5.09	0.000	-.6104633	-.2709891
_cons	20.56321	.1440368	142.76	0.000	20.28089	20.84552
q20						
fv	-.1099771	.013762	-7.99	0.000	-.136951	-.0830031
Phys_act	-.0088756	.0011599	-7.65	0.000	-.011149	-.0066022
csmoker	-.3589596	.1011325	-3.55	0.000	-.5571827	-.1607366
fsmoker	.623005	.058423	10.66	0.000	.508494	.737516
age1	1.186409	.0782111	15.17	0.000	1.033113	1.339705
age2	1.716397	.102879	16.68	0.000	1.514751	1.918044
partner	.4188519	.0607246	6.90	0.000	.2998296	.5378741
WSD	-.0185742	.0825934	-0.22	0.822	-.18046	.1433116
edu1	-.3675	.0899907	-4.08	0.000	-.5438846	-.1911153
edu2	-.5084482	.1710622	-2.97	0.003	-.8437358	-.1731606
edu3	-.7739284	.0944467	-8.19	0.000	-.9590471	-.5888097
IMM	-.7242087	.0652755	-11.09	0.000	-.8521509	-.5962665
income1	.5258733	.0905592	5.81	0.000	.3483742	.7033724
income2	1.108161	.0815066	13.60	0.000	.948405	1.267916
ON	-.3908549	.1053029	-3.71	0.000	-.5972521	-.1844577
BC	-.7859235	.1286408	-6.11	0.000	-1.038064	-.5337832
Quebec	-1.018753	.1215576	-8.38	0.000	-1.25701	-.7804964
Western	-.3617572	.0863905	-4.19	0.000	-.5310853	-.192429
_cons	22.44073	.1393337	161.06	0.000	22.16763	22.71383
q30						
fv	-.1080775	.0143631	-7.52	0.000	-.1362295	-.0799254
Phys_act	-.0131666	.0013207	-9.97	0.000	-.0157553	-.0105779
csmoker	-.4673305	.0713673	-6.55	0.000	-.6072127	-.3274483
fsmoker	.6085127	.0735907	8.27	0.000	.4642725	.752753
age1	1.359331	.0930835	14.60	0.000	1.176884	1.541777
age2	1.86196	.08248	22.57	0.000	1.700297	2.023624
partner	.4112536	.0597106	6.89	0.000	.294219	.5282883
WSD	.0065255	.0740416	0.09	0.930	-.1385985	.1516494
edu1	-.4146979	.1126343	-3.68	0.000	-.6354648	-.193931
edu2	-.5601458	.1739018	-3.22	0.001	-.9009991	-.2192924
edu3	-.8956924	.1096261	-8.17	0.000	-1.110563	-.6808216
IMM	-.7628731	.0815468	-9.36	0.000	-.9227075	-.6030386
income1	.4638416	.0803094	5.78	0.000	.3064324	.6212507
income2	1.040975	.08619	12.08	0.000	.8720399	1.209911
ON	-.4817304	.1214521	-3.97	0.000	-.7197805	-.2436803
BC	-1.004157	.1245284	-8.06	0.000	-1.248237	-.7600777
Quebec	-1.147857	.1080873	-10.62	0.000	-1.359712	-.9360026
Western	-.4205675	.1099232	-3.83	0.000	-.6360206	-.2051144

_cons	23.93947	.1471247	162.72	0.000	23.6511	24.22784
q40						
fv	-.1072527	.0121634	-8.82	0.000	-.1310935	-.0834119
Phys_act	-.0159719	.0010996	-14.53	0.000	-.018127	-.0138167
csmoker	-.4726978	.0896778	-5.27	0.000	-.6484692	-.2969264
fsmoker	.6494529	.0782262	8.30	0.000	.496127	.8027788
age1	1.494716	.094062	15.89	0.000	1.310351	1.679081
age2	1.932006	.0892177	21.65	0.000	1.757136	2.106875
partner	.4189078	.057941	7.23	0.000	.3053415	.5324741
WSD	.0492265	.0866796	0.57	0.570	-.1206685	.2191214
edu1	-.483263	.0719328	-6.72	0.000	-.6242536	-.3422724
edu2	-.7617013	.1483193	-5.14	0.000	-1.052412	-.4709905
edu3	-.9482526	.0781386	-12.14	0.000	-1.101407	-.7950985
IMM	-.8110369	.0974005	-8.33	0.000	-1.001945	-.6201288
income1	.3979235	.0646293	6.16	0.000	.271248	.5245991
income2	.9469389	.0744156	12.73	0.000	.8010819	1.092796
ON	-.4422985	.125639	-3.52	0.000	-.6885552	-.1960419
BC	-1.006329	.1256053	-8.01	0.000	-1.25252	-.7601387
Quebec	-1.210633	.1276235	-9.49	0.000	-1.460779	-.9604863
Western	-.3486438	.0991512	-3.52	0.000	-.5429834	-.1543041
_cons	25.13758	.1282537	196.00	0.000	24.8862	25.38896
q50						
fv	-.1152191	.0143444	-8.03	0.000	-.1433347	-.0871035
Phys_act	-.0193797	.0013329	-14.54	0.000	-.0219923	-.0167671
csmoker	-.4515605	.0810217	-5.57	0.000	-.6103658	-.2927552
fsmoker	.608552	.0722073	8.43	0.000	.4670233	.7500807
age1	1.536692	.1139562	13.48	0.000	1.313334	1.76005
age2	1.85241	.1209176	15.32	0.000	1.615407	2.089412
partner	.4321515	.0848784	5.09	0.000	.2657871	.5985159
WSD	.2253547	.131	1.72	0.085	-.0314097	.4821191
edu1	-.4255833	.1004009	-4.24	0.000	-.6223725	-.2287941
edu2	-.736959	.2074856	-3.55	0.000	-1.143638	-.3302804
edu3	-.8837579	.1024977	-8.62	0.000	-1.084657	-.682859
IMM	-.9671664	.0854465	-11.32	0.000	-1.134644	-.7996884
income1	.2252417	.0706951	3.19	0.001	.086677	.3638064
income2	.7112592	.0894534	7.95	0.000	.5359276	.8865909
ON	-.3897876	.1440907	-2.71	0.007	-.6722101	-.1073651
BC	-1.085116	.1355972	-8.00	0.000	-1.350891	-.8193414
Quebec	-1.249391	.1391855	-8.98	0.000	-1.522199	-.9765832
Western	-.2419985	.1262943	-1.92	0.055	-.4895396	.0055426
_cons	26.50578	.145895	181.68	0.000	26.21982	26.79174
q70						
fv	-.113482	.0144674	-7.84	0.000	-.1418386	-.0851253

Phys_act	-.029615	.0017538	-16.89	0.000	-.0330526	-.0261774
csmoker	-.5967943	.1227973	-4.86	0.000	-.8374811	-.3561074
fsmoker	.6261692	.1214458	5.16	0.000	.3881315	.8642069
age1	1.576142	.0960373	16.41	0.000	1.387906	1.764378
age2	1.592464	.1182106	13.47	0.000	1.360768	1.824161
partner	.2054091	.0998527	2.06	0.040	.0096946	.4011236
WSD	.3239641	.1453102	2.23	0.026	.0391513	.6087769
edu1	-.7352686	.1237005	-5.94	0.000	-.9777258	-.4928115
edu2	-.8950896	.3181053	-2.81	0.005	-1.518586	-.2715927
edu3	-1.103855	.1520515	-7.26	0.000	-1.401881	-.805829
IMM	-1.441807	.0922693	-15.63	0.000	-1.622658	-1.260956
income1	.0397256	.0988219	0.40	0.688	-.1539685	.2334198
income2	.1825721	.0938852	1.94	0.052	-.001446	.3665902
ON	-.4749548	.1574532	-3.02	0.003	-.7835683	-.1663412
BC	-1.270476	.1685945	-7.54	0.000	-1.600926	-.9400249
Quebec	-1.487263	.1473162	-10.10	0.000	-1.776007	-1.198518
Western	-.1373173	.1271597	-1.08	0.280	-.3865545	.1119199
_cons	30.32445	.1891498	160.32	0.000	29.95371	30.69519
q80						
fv	-.1224686	.0172894	-7.08	0.000	-.1563565	-.0885807
Phys_act	-.0365283	.0022543	-16.20	0.000	-.0409467	-.0321098
csmoker	-.6826069	.1434166	-4.76	0.000	-.9637082	-.4015057
fsmoker	.6430332	.1333518	4.82	0.000	.3816593	.9044071
age1	1.596898	.1433002	11.14	0.000	1.316025	1.877771
age2	1.336852	.1258135	10.63	0.000	1.090253	1.58345
partner	.0109691	.1311304	0.08	0.933	-.2460509	.2679891
WSD	.2891015	.1971385	1.47	0.143	-.0972964	.6754994
edu1	-.7539621	.1431718	-5.27	0.000	-1.034584	-.4733406
edu2	-.5514497	.4583455	-1.20	0.229	-1.449822	.3469226
edu3	-1.145264	.1787769	-6.41	0.000	-1.495673	-.7948556
IMM	-1.772793	.132848	-13.34	0.000	-2.03318	-1.512407
income1	-.2595669	.1297592	-2.00	0.045	-.5138992	-.0052346
income2	-.3326253	.1348427	-2.47	0.014	-.5969214	-.0683292
ON	-.2350048	.1113655	-2.11	0.035	-.4532849	-.0167247
BC	-1.29893	.2365329	-5.49	0.000	-1.762543	-.8353181
Quebec	-1.58834	.1247562	-12.73	0.000	-1.832866	-1.343814
Western	.0232021	.100676	0.23	0.818	-.1741261	.2205304
_cons	32.95161	.2438027	135.16	0.000	32.47375	33.42947
q90						
fv	-.1192539	.029042	-4.11	0.000	-.1761771	-.0623307
Phys_act	-.0451451	.0038468	-11.74	0.000	-.0526849	-.0376053
csmoker	-.9978836	.2564604	-3.89	0.000	-1.500554	-.4952128
fsmoker	.6289709	.1766334	3.56	0.000	.2827635	.9751783
age1	1.612693	.2192501	7.36	0.000	1.182956	2.042431

age2	1.040072	.1463975	7.10	0.000	.7531278	1.327016
partner	-.6521235	.2450019	-2.66	0.008	-1.132335	-.1719117
WSD	.1089857	.2913105	0.37	0.708	-.4619926	.6799639
edu1	-.8716144	.2657076	-3.28	0.001	-1.39241	-.3508187
edu2	-.4675344	.5191493	-0.90	0.368	-1.485084	.5500154
edu3	-1.134513	.3255523	-3.48	0.000	-1.772607	-.4964199
IMM	-2.310571	.2172585	-10.64	0.000	-2.736405	-1.884737
income1	-.7526888	.1796151	-4.19	0.000	-1.10474	-.4006373
income2	-1.097102	.1928009	-5.69	0.000	-1.474998	-.7192055
ON	-.1713705	.2455607	-0.70	0.485	-.6526777	.3099367
BC	-1.118545	.2998599	-3.73	0.000	-1.70628	-.5308098
Quebec	-1.684051	.3160911	-5.33	0.000	-2.3036	-1.064502
Western	.4285141	.3058064	1.40	0.161	-.1708766	1.027905
_cons	37.31111	.4808928	77.59	0.000	36.36855	38.25368

B. Quantile results for male

Number of obs = 15,886

.10 Pseudo R2 = 0.0671, .20 Pseudo R2 = 0.0578, .30 Pseudo R2 = 0.0543

.40 Pseudo R2 = 0.0487, .50 Pseudo R2 = 0.0458, .70 Pseudo R2 = 0.0388

.80 Pseudo R2 = 0.0370, .90 Pseudo R2 = 0.0374

BMI	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.	Interval]
q10						
fv	-.0205606	.0174124	-1.18	0.238	-.0546908	.0135697
Phys_act	.0005959	.001342	0.44	0.657	-.0020347	.0032265
csmoker	-.4500828	.1093461	-4.12	0.000	-.6644135	-.235752
fsmoker	.4934124	.0934543	5.28	0.000	.3102314	.6765934
age1	1.175931	.1329031	8.85	0.000	.9154259	1.436436
age2	1.281158	.1201607	10.66	0.000	1.045629	1.516686
partner	.7073128	.1054075	6.71	0.000	.5007021	.9139235
WSD	.3913286	.2013544	1.94	0.052	-.0033488	.786006
edu1	-.0303929	.2343962	-0.13	0.897	-.4898361	.4290503
edu2	-.0053406	.2300751	-0.02	0.981	-.4563138	.4456326
edu3	-.1603122	.199994	-0.80	0.423	-.5523231	.2316988

IMM	-.9589789	.1246773	-7.69	0.000	-1.203361	-.7145972
income1	1.101058	.1609891	6.84	0.000	.7855015	1.416615
income2	1.678588	.1698312	9.88	0.000	1.3457	2.011477
ON	-.228152	.1197323	-1.91	0.057	-.4628409	.0065369
BC	-.6384149	.1474254	-4.33	0.000	-.9273854	-.3494444
Quebec	-.7866361	.1113345	-7.07	0.000	-1.004864	-.5684078
Western	-.1333472	.1253406	-1.06	0.287	-.3790291	.1123346
_cons	20.28952	.361839	56.07	0.000	19.58028	20.99877
q20						
fv	-.0519251	.0239271	-2.17	0.030	-.098825	-.0050252
Phys_act	-.001363	.0012195	-1.12	0.264	-.0037534	.0010274
csmoker	-.8750154	.1167061	-7.50	0.000	-1.103773	-.6462582
fsmoker	.3379104	.0799159	4.23	0.000	.1812663	.4945546
age1	1.307092	.1354004	9.65	0.000	1.041692	1.572492
age2	1.392957	.1229105	11.33	0.000	1.152038	1.633876
partner	.7633151	.1131709	6.74	0.000	.5414874	.9851429
WSD	.4794916	.1874686	2.56	0.011	.1120318	.8469514
edu1	-.173369	.1322694	-1.31	0.190	-.432632	.085894
edu2	-.1916569	.120134	-1.60	0.111	-.4271332	.0438195
edu3	-.4622705	.1014176	-4.56	0.000	-.6610606	-.2634804
IMM	-.9386287	.1149199	-8.17	0.000	-1.163885	-.7133727
income1	.8177925	.1238379	6.60	0.000	.5750562	1.060529
income2	1.335902	.1228363	10.88	0.000	1.095129	1.576675
ON	-.2788893	.1423063	-1.96	0.050	-.5578258	.0000471
BC	-.7501669	.1513523	-4.96	0.000	-1.046835	-.4534991
Quebec	-.6680534	.1277943	-5.23	0.000	-.9185447	-.4175621
Western	-.1600583	.1234523	-1.30	0.195	-.4020388	.0819222
_cons	22.38996	.1994601	112.25	0.000	21.999	22.78093
q30						
fv	-.0681544	.0165597	-4.12	0.000	-.1006132	-.0356956
Phys_act	-.0029121	.0009321	-3.12	0.002	-.0047392	-.0010851
csmoker	-.8390493	.1135724	-7.39	0.000	-1.061664	-.6164344
fsmoker	.3657965	.0909611	4.02	0.000	.1875023	.5440907
age1	1.32829	.1065363	12.47	0.000	1.119466	1.537113
age2	1.376236	.0998243	13.79	0.000	1.180569	1.571903
partner	.8296221	.115206	7.20	0.000	.6038052	1.055439
WSD	.5390308	.1713364	3.15	0.002	.2031921	.8748696
edu1	-.1703251	.16092	-1.06	0.290	-.4857465	.1450964
edu2	-.2571759	.1399888	-1.84	0.066	-.5315697	.017218
edu3	-.3850238	.089593	-4.30	0.000	-.5606362	-.2094114
IMM	-.953703	.1221304	-7.81	0.000	-1.193092	-.7143136
income1	.659575	.0662395	9.96	0.000	.529738	.789412
income2	1.067047	.0835605	12.77	0.000	.9032588	1.230835
ON	-.1767849	.1361924	-1.30	0.194	-.4437374	.0901677

BC	-.7564237	.1557563	-4.86	0.000	-1.061724	-.4511236
Quebec	-.6245636	.1223711	-5.10	0.000	-.8644248	-.3847023
Western	-.1682452	.100294	-1.68	0.093	-.3648328	.0283425
_cons	23.61336	.1665295	141.80	0.000	23.28694	23.93977
q40						
fv	-.0742372	.0185736	-4.00	0.000	-.1106436	-.0378308
Phys_act	-.0069608	.0010634	-6.55	0.000	-.0090451	-.0048766
csmoker	-.8773437	.0957943	-9.16	0.000	-1.065111	-.689576
fsmoker	.3146896	.094682	3.32	0.001	.1291021	.5002772
age1	1.308126	.1068791	12.24	0.000	1.098631	1.517621
age2	1.419807	.1108016	12.81	0.000	1.202623	1.63699
partner	.8727102	.0984314	8.87	0.000	.6797735	1.065647
WSD	.6342989	.1375172	4.61	0.000	.3647496	.9038482
edu1	-.2442419	.1816823	-1.34	0.179	-.6003598	.111876
edu2	-.5814379	.1717958	-3.38	0.001	-.918177	-.2446987
edu3	-.5590979	.1224227	-4.57	0.000	-.7990603	-.3191355
IMM	-.9969997	.1092737	-9.12	0.000	-1.211189	-.7828107
income1	.6095275	.0929988	6.55	0.000	.4272392	.7918157
income2	.956059	.1015989	9.41	0.000	.7569136	1.155204
ON	-.1333165	.116765	-1.14	0.254	-.3621891	.0955561
BC	-.7059605	.1275224	-5.54	0.000	-.955919	-.4560021
Quebec	-.652327	.1142457	-5.71	0.000	-.8762616	-.4283925
Western	-.0827177	.1119791	-0.74	0.460	-.3022095	.1367741
_cons	24.87897	.1592283	156.25	0.000	24.56686	25.19107
q50						
fv	-.0839458	.0167992	-5.00	0.000	-.1168741	-.0510174
Phys_act	-.0108405	.0014469	-7.49	0.000	-.0136767	-.0080044
csmoker	-.8878108	.1324988	-6.70	0.000	-1.147523	-.6280982
fsmoker	.2863358	.1187029	2.41	0.016	.0536646	.5190069
age1	1.278746	.1161858	11.01	0.000	1.051008	1.506483
age2	1.305908	.1069219	12.21	0.000	1.096329	1.515487
partner	.8751913	.1033062	8.47	0.000	.6726993	1.077683
WSD	.7260181	.1561588	4.65	0.000	.4199293	1.032107
edu1	-.365941	.1811438	-2.02	0.043	-.7210034	-.0108787
edu2	-.7770633	.1942303	-4.00	0.000	-1.157777	-.3963499
edu3	-.6333534	.1408603	-4.50	0.000	-.9094555	-.3572513
IMM	-1.151031	.1342689	-8.57	0.000	-1.414213	-.8878482
income1	.3654012	.102047	3.58	0.000	.1653774	.5654249
income2	.6459045	.1077836	5.99	0.000	.4346365	.8571725
ON	-.1015153	.1310109	-0.77	0.438	-.3583115	.1552809
BC	-.724489	.1483479	-4.88	0.000	-1.015268	-.4337103
Quebec	-.706001	.1421261	-4.97	0.000	-.9845842	-.4274178
Western	.0379589	.1684992	0.23	0.822	-.2923188	.3682365
_cons	26.41159	.1501177	175.94	0.000	26.11734	26.70584

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q70               |
               fv |  -.1037959   .0237836    -4.36   0.000    -.1504144   -.0571774
         Phys_act |  -.0198689   .0017597   -11.29   0.000    -.0233182   -.0164196
          csmoker |  -1.056466   .1721672    -6.14   0.000    -1.393933   -.7189985
          fsmoker |   .1785517   .1713945     1.04   0.298    -.1574011    .5145044
             age1 |   1.296038    .173547     7.47   0.000     .9558662     1.63621
             age2 |   1.198495   .1646585     7.28   0.000     .8757454    1.521244
          partner |   .6660179   .1377053     4.84   0.000     .3960998     .935936
              WSD |   .7724963   .1955347     3.95   0.000     .3892261    1.155767
             edu1 |  -.7461542   .2395629    -3.11   0.002    -1.215725   -.2765837
             edu2 |  -.9929864   .3856774    -2.57   0.010    -1.748958    -.237015
             edu3 |  -1.012536   .1805718    -5.61   0.000    -1.366478   -.6585949
              IMM |  -1.545587   .1723381    -8.97   0.000    -1.883389   -1.207784
          income1 |   .0177476   .1159568     0.15   0.878    -.2095409     .245036
          income2 |   .2489099   .1355252     1.84   0.066    -.0167348    .5145546
               ON |  -.2785045   .1502466    -1.85   0.064    -.5730049    .0159959
               BC |  -.9930956   .2221691    -4.47   0.000    -1.428572   -.5576188
           Quebec |   -1.08588   .1525303    -7.12   0.000    -1.384857   -.7869037
          Western |   .0323827    .190364     0.17   0.865    -.3407524    .4055177
            _cons |   30.24566   .1551232   194.98   0.000      29.9416    30.54972
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q80               |
               fv |  -.1221883   .0264617    -4.62   0.000    -.1740561   -.0703205
         Phys_act |  -.0227402   .0016213   -14.03   0.000    -.0259181   -.0195624
          csmoker |  -1.129317    .214369    -5.27   0.000    -1.549504   -.7091292
          fsmoker |   .3026848   .1973566     1.53   0.125    -.0841566    .6895262
             age1 |   1.307868   .2116041     6.18   0.000     .8930997    1.722636
             age2 |   1.060452   .1959223     5.41   0.000     .6764222    1.444482
          partner |   .5239917   .1726752     3.03   0.002     .1855286    .8624547
              WSD |   .7114315   .1927255     3.69   0.000     .3336677    1.089195
             edu1 |  -.8963333   .2860988    -3.13   0.002    -1.457119   -.3355471
             edu2 |  -.8769716   .4511164    -1.94   0.052    -1.761211    .0072677
             edu3 |  -1.171872   .2272831    -5.16   0.000    -1.617372    -.726371
              IMM |  -1.650031   .2390755    -6.90   0.000    -2.118646   -1.181415
          income1 |  -.3121137   .1644185    -1.90   0.058    -.6343926    .0101652
          income2 |  -.1811631   .1472127    -1.23   0.218    -.4697166    .1073905
               ON |    -.09767   .2180889    -0.45   0.654     -.525149    .3298089
               BC |  -1.060959   .2988146    -3.55   0.000     -1.64667   -.4752489
           Quebec |  -.9924734   .2301639    -4.31   0.000    -1.443621   -.5413261
          Western |   .0957942    .204635     0.47   0.640    -.3053135     .496902
            _cons |    32.5479   .3717628    87.55   0.000      31.8192     33.2766
------------------+---------------------------------------------------------------
q90               |
               fv |  -.1162786   .0462111    -2.52   0.012    -.2068577   -.0256996
         Phys_act |  -.0316363   .0033735    -9.38   0.000    -.0382487   -.0250238
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	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
csmoker	-1.33563	.3512877	-3.80	0.000	-2.024193	-.6470659
fsmoker	.4037071	.2871005	1.41	0.160	-.1590425	.9664567
age1	1.287743	.3168282	4.06	0.000	.666724	1.908763
age2	.965063	.3787576	2.55	0.011	.2226552	1.707471
partner	-.0149943	.2521045	-0.06	0.953	-.5091477	.4791591
WSD	-.0907302	.4095825	-0.22	0.825	-.8935584	.7120979
edu1	-1.594377	.4598703	-3.47	0.001	-2.495775	-.6929788
edu2	-1.238327	.7084051	-1.75	0.080	-2.626881	.1502278
edu3	-1.555138	.3682914	-4.22	0.000	-2.277031	-.8332451
IMM	-2.09603	.3682483	-5.69	0.000	-2.817839	-1.374222
income1	-.6744168	.2558969	-2.64	0.008	-1.176004	-.1728298
income2	-.8223779	.2898395	-2.84	0.005	-1.390496	-.2542596
ON	.249892	.2926748	0.85	0.393	-.3237838	.8235677
BC	-.5723171	.371987	-1.54	0.124	-1.301454	.1568197
Quebec	-.7986022	.4013965	-1.99	0.047	-1.585385	-.0118195
Western	.9011573	.2100096	4.29	0.000	.4895146	1.3128
_cons	36.53602	.5278505	69.22	0.000	35.50137	37.57067

C. Quantile results for female

Number of obs = 18,429

.10 Pseudo R2 = 0.0299, .20 Pseudo R2 = 0.0378, .30 Pseudo R2 = 0.0442

.40 Pseudo R2 = 0.049, .50 Pseudo R2 = 0.0504, .70 Pseudo R2 = 0.0493

.80 Pseudo R2 = 0.0507, .90 Pseudo R2 = 0.0544

BMI	Bootstrap Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
q10						
fv	-.038181	.0138067	-2.77	0.006	-.0652434	-.0111187
Phys_act	-.0081907	.0013603	-6.02	0.000	-.010857	-.0055243
csmoker	-.4948923	.0964386	-5.13	0.000	-.683921	-.3058636
fsmoker	.4368974	.0690887	6.32	0.000	.3014773	.5723176
age1	.9603012	.0944878	10.16	0.000	.7750962	1.145506
age2	1.413585	.1064095	13.28	0.000	1.205013	1.622158
partner	.4211386	.0972825	4.33	0.000	.230456	.6118213
WSD	.276269	.1309496	2.11	0.035	.0195957	.5329423

edu1	.1025921	.1345864	0.76	0.446	-.1612097	.3663939
edu2	-.3013146	.2216682	-1.36	0.174	-.7358049	.1331758
edu3	-.2255016	.1298741	-1.74	0.083	-.4800669	.0290638
IMM	-.573924	.1211146	-4.74	0.000	-.8113198	-.3365282
income1	.231804	.0797953	2.90	0.004	.0753978	.3882101
income2	.0461478	.1308529	0.35	0.724	-.210336	.3026317
ON	-.3011822	.1512509	-1.99	0.046	-.597648	-.0047165
BC	-.5730397	.1655328	-3.46	0.001	-.8974994	-.2485799
Quebec	-.780783	.1514288	-5.16	0.000	-1.077597	-.4839685
Western	-.2734035	.1617795	-1.69	0.091	-.5905063	.0436993
_cons	19.98844	.173126	115.46	0.000	19.6491	20.32779
q20						
fv	-.0437208	.0144698	-3.02	0.003	-.0720829	-.0153587
Phys_act	-.0137194	.001661	-8.26	0.000	-.0169751	-.0104637
csmoker	-.3171251	.0915065	-3.47	0.001	-.4964864	-.1377638
fsmoker	.541505	.0868562	6.23	0.000	.3712588	.7117513
age1	1.159715	.1012899	11.45	0.000	.9611769	1.358252
age2	1.696494	.1153287	14.71	0.000	1.470439	1.922548
partner	.4235105	.0911055	4.65	0.000	.2449354	.6020857
WSD	.2387986	.1250355	1.91	0.056	-.0062825	.4838797
edu1	-.2072753	.2273817	-0.91	0.362	-.6529646	.238414
edu2	-.3533875	.2486494	-1.42	0.155	-.8407635	.1339884
edu3	-.4963889	.2336634	-2.12	0.034	-.9543909	-.038387
IMM	-.6898515	.0907183	-7.60	0.000	-.8676677	-.5120352
income1	.1065658	.0650489	1.64	0.101	-.020936	.2340677
income2	-.2215629	.1330196	-1.67	0.096	-.4822937	.039168
ON	-.5197923	.1318107	-3.94	0.000	-.7781535	-.2614311
BC	-.9347159	.1508089	-6.20	0.000	-1.230315	-.6391165
Quebec	-1.162183	.0943782	-12.31	0.000	-1.347173	-.9771931
Western	-.5332648	.1404735	-3.80	0.000	-.808606	-.2579237
_cons	21.96305	.2666412	82.37	0.000	21.44041	22.48569
q30						
fv	-.0405424	.014685	-2.76	0.006	-.0693262	-.0117585
Phys_act	-.0203373	.0014104	-14.42	0.000	-.0231019	-.0175727
csmoker	-.3074073	.1151184	-2.67	0.008	-.5330501	-.0817646
fsmoker	.5745299	.1136551	5.06	0.000	.3517554	.7973044
age1	1.340815	.1051946	12.75	0.000	1.134624	1.547006
age2	2.007048	.1405928	14.28	0.000	1.731473	2.282623
partner	.4108235	.1124903	3.65	0.000	.1903321	.631315
WSD	.3149533	.1409112	2.24	0.025	.0387543	.5911522
edu1	-.4703043	.1692562	-2.78	0.005	-.8020621	-.1385465
edu2	-.6860809	.2407608	-2.85	0.004	-1.157994	-.2141674
edu3	-.8545716	.2029494	-4.21	0.000	-1.252371	-.456772
IMM	-.7363702	.1074376	-6.85	0.000	-.9469579	-.5257824

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     income1 |   .0330815   .0968833     0.34   0.733    -.1568188    .2229819
     income2 |  -.2994938    .148904    -2.01   0.044    -.5913594   -.0076282
          ON |  -.5820617    .141163    -4.12   0.000    -.8587542   -.3053692
          BC |  -1.137861   .1472976    -7.72   0.000    -1.426578   -.8491444
      Quebec |  -1.448943   .1195288   -12.12   0.000    -1.683231   -1.214656
     Western |   -.571068   .1673029    -3.41   0.001    -.8989972   -.2431388
       _cons |   23.58302   .2185974   107.88   0.000     23.15455    24.01149
-------------+----------------------------------------------------------------
q40          |
          fv |  -.0442737     .01646    -2.69   0.007    -.0765369   -.0120105
   Phys_act |  -.0265691   .0015542   -17.09   0.000    -.0296156   -.0235227
     csmoker |  -.3292896   .1302848    -2.53   0.011    -.5846599   -.0739193
     fsmoker |   .6135429   .1114421     5.51   0.000      .395106    .8319797
        age1 |   1.593435   .0746744    21.34   0.000     1.447067    1.739804
        age2 |   2.305432   .0875848    26.32   0.000     2.133758    2.477106
     partner |   .2886888   .1207005     2.39   0.017     .0521046     .525273
         WSD |   .1811039   .1372912     1.32   0.187    -.0879996    .4502074
        edu1 |  -.6346459   .1335561    -4.75   0.000    -.8964282   -.3728637
        edu2 |   -.875759   .1910361    -4.58   0.000    -1.250207   -.5013105
        edu3 |  -.8766366   .1701117    -5.15   0.000    -1.210071   -.5432018
         IMM |  -.8075893   .0947966    -8.52   0.000    -.9933995   -.6217791
     income1 |  -.0944205   .1127687    -0.84   0.402    -.3154576    .1266166
     income2 |  -.4390519   .1362616    -3.22   0.001    -.7061372   -.1719666
          ON |  -.6856292   .1179673    -5.81   0.000     -.916856   -.4544024
          BC |  -1.357987   .1513476    -8.97   0.000    -1.654642   -1.061331
      Quebec |  -1.679324   .1117116   -15.03   0.000    -1.898289   -1.460358
     Western |  -.5149501   .1532501    -3.36   0.001    -.8153346   -.2145656
       _cons |    25.0667    .187886   133.41   0.000     24.69843    25.43498
-------------+----------------------------------------------------------------
q50          |
          fv |  -.0408902   .0177123    -2.31   0.021    -.0756079   -.0061724
    Phys_act |  -.0325607    .001565   -20.81   0.000    -.0356283   -.0294931
     csmoker |  -.1406949   .1199197    -1.17   0.241    -.3757486    .0943588
     fsmoker |   .7893382   .1218158     6.48   0.000     .5505679    1.028109
        age1 |   1.909795   .1174684    16.26   0.000     1.679546    2.140044
        age2 |   2.480839   .1338273    18.54   0.000     2.218525    2.743153
     partner |   .1071665   .1563071     0.69   0.493    -.1992098    .4135429
         WSD |   .1840764   .1585285     1.16   0.246    -.1266542     .494807
        edu1 |   -.364532   .1955995    -1.86   0.062    -.7479252    .0188611
        edu2 |  -.7341858   .2849913    -2.58   0.010    -1.292795   -.1755764
        edu3 |  -.7430093   .2059727    -3.61   0.000    -1.146735   -.3392837
         IMM |  -.8167535   .1378964    -5.92   0.000    -1.087043   -.5464638
     income1 |  -.2579569   .1502547    -1.72   0.086    -.5524701    .0365563
     income2 |  -.5869472   .1938663    -3.03   0.002    -.9669431   -.2069514
          ON |  -.5831226   .1629932    -3.58   0.000    -.9026045   -.2636407
          BC |  -1.401321   .1836164    -7.63   0.000    -1.761226   -1.041416
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     Quebec |  -1.745138   .1432027   -12.19   0.000    -2.025828   -1.464447
    Western |  -.4460512   .2142892    -2.08   0.037    -.8660779   -.0260246
      _cons |   26.14097   .2450209   106.69   0.000      25.6607    26.62123
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q70         |
         fv |   -.058516   .0242618    -2.41   0.016    -.1060714   -.0109606
   Phys_act |  -.0473224   .0022307   -21.21   0.000    -.0516948     -.04295
    csmoker |  -.2857161   .1731798    -1.65   0.099    -.6251645    .0537324
    fsmoker |   .8857458   .1373706     6.45   0.000     .6164867    1.155005
       age1 |   2.118336   .1981443    10.69   0.000     1.729955    2.506718
       age2 |   2.156843    .218049     9.89   0.000     1.729447     2.58424
    partner |  -.3992286   .1514049    -2.64   0.008    -.6959963    -.102461
        WSD |   .1107101   .1759278     0.63   0.529    -.2341246    .4555449
       edu1 |  -.5541532   .2046802    -2.71   0.007    -.9553454    -.152961
       edu2 |  -.4913209   .3457982    -1.42   0.155    -1.169117    .1864757
       edu3 |   -.929392   .1988686    -4.67   0.000    -1.319193   -.5395911
        IMM |  -1.307045     .12755   -10.25   0.000    -1.557054   -1.057035
    income1 |  -.1908429   .1463691    -1.30   0.192    -.4777399     .096054
    income2 |  -.8191836   .1318596    -6.21   0.000    -1.077641   -.5607266
         ON |  -.5215131   .1695314    -3.08   0.002    -.8538105   -.1892158
         BC |  -1.579755   .1754099    -9.01   0.000    -1.923575   -1.235935
     Quebec |  -2.006303   .2239534    -8.96   0.000    -2.445273   -1.567334
    Western |  -.1916669   .2597811    -0.74   0.461    -.7008619    .3175282
      _cons |   30.31501   .3298792    91.90   0.000     29.66841     30.9616
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q80         |
         fv |  -.1038315   .0347754    -2.99   0.003    -.1719946   -.0356685
   Phys_act |   -.055219    .002992   -18.46   0.000    -.0610837   -.0493543
    csmoker |  -.2387729   .2656341    -0.90   0.369    -.7594405    .2818947
    fsmoker |   .9045579   .1541766     5.87   0.000     .6023574    1.206758
       age1 |   1.971554   .2173912     9.07   0.000     1.545447    2.397661
       age2 |   1.663323   .2670273     6.23   0.000     1.139925    2.186722
    partner |  -.6280479   .1906409    -3.29   0.001    -1.001722    -.254374
        WSD |  -.2285681   .2410095    -0.95   0.343    -.7009691    .2438328
       edu1 |  -.5238368   .2374673    -2.21   0.027    -.9892948   -.0583788
       edu2 |   -.333373     .34728    -0.96   0.337    -1.014074    .3473281
       edu3 |  -.9697104   .2287575    -4.24   0.000    -1.418096   -.5213245
        IMM |  -1.780701   .1324642   -13.44   0.000    -2.040343   -1.521059
    income1 |  -.3661961     .15585    -2.35   0.019    -.6716766   -.0607156
    income2 |  -1.028169    .191049    -5.38   0.000    -1.402643   -.6536953
         ON |  -.1945831   .1625097    -1.20   0.231    -.5131172    .1239511
         BC |  -1.323151    .267009    -4.96   0.000    -1.846513   -.7997883
     Quebec |  -2.107682    .208148   -10.13   0.000    -2.515671   -1.699692
    Western |    .067995   .2840716     0.24   0.811    -.4888118    .6248017
      _cons |     33.397   .3961239    84.31   0.000     32.62056    34.17344
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	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
q90						
fv	-.1194233	.0340793	-3.50	0.000	-.1862219	-.0526247
Phys_act	-.0614227	.0035435	-17.33	0.000	-.0683684	-.0544771
csmoker	-.6359651	.2550413	-2.49	0.013	-1.13587	-.1360604
fsmoker	.7861363	.2495003	3.15	0.002	.2970925	1.27518
age1	1.840016	.2987538	6.16	0.000	1.25443	2.425601
age2	1.094596	.3086314	3.55	0.000	.4896496	1.699542
partner	-1.14804	.3083862	-3.72	0.000	-1.752506	-.5435748
WSD	-.1652216	.3809864	-0.43	0.665	-.9119903	.5815472
edu1	-.0913185	.3787138	-0.24	0.809	-.8336327	.6509957
edu2	.65111	.527258	1.23	0.217	-.3823645	1.684585
edu3	-.5625588	.3892595	-1.45	0.148	-1.325544	.200426
IMM	-2.437734	.232061	-10.50	0.000	-2.892595	-1.982873
income1	-.798406	.2748897	-2.90	0.004	-1.337215	-.2595965
income2	-1.731049	.2490348	-6.95	0.000	-2.21918	-1.242918
ON	-.3267069	.2751971	-1.19	0.235	-.8661188	.212705
BC	-1.368829	.3279225	-4.17	0.000	-2.011587	-.7260701
Quebec	-2.601735	.3185245	-8.17	0.000	-3.226072	-1.977397
Western	.1806121	.2719187	0.66	0.507	-.3523738	.713598
_cons	37.83696	.6442499	58.73	0.000	36.57417	39.09975

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